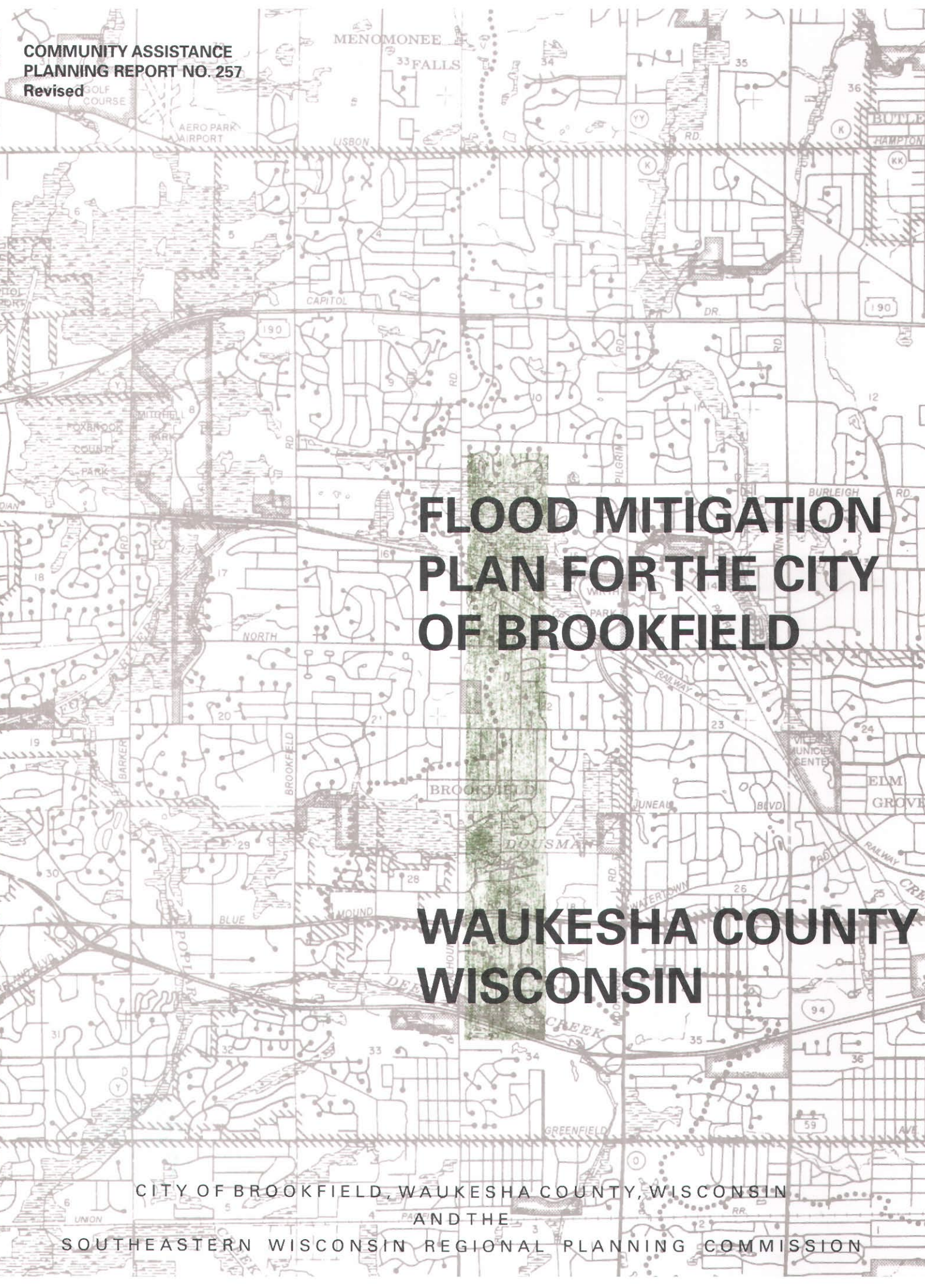
COMMUNITY ASSISTANCE
PLANNING REPORT NO. 257
Revised



FLOOD MITIGATION PLAN FOR THE CITY OF BROOKFIELD

WAUKESHA COUNTY WISCONSIN

CITY OF BROOKFIELD, WAUKESHA COUNTY, WISCONSIN

AND THE

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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COMMUNITY ASSISTANCE PLANNING REPORT
NUMBER 257

FLOOD MITIGATION PLAN FOR THE CITY OF BROOKFIELD WAUKESHA COUNTY, WISCONSIN

Prepared by the

City of Brookfield
and the
Southeastern Wisconsin Regional Planning Commission

Revised August 2001

Inside Region $10.00
Outside Region $20.00

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Chapter I

INTRODUCTION AND BACKGROUND

On October 12, 1999, the City of Brookfield requested the assistance of the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in the preparation of a flood mitigation plan for the City. In addition to setting forth updated flood mitigation recommendations for the City and for the two watersheds that lie partly within the City, the plan is designed to set forth current information regarding the status of flooding problems and planning for their mitigation, as well as plan implementation efforts, including public involvement activities undertaken as a part of flood mitigation planning, within and for the City and the two watersheds. The plan was prepared by City staff and Regional Planning Commission staff and was coordinated with the related activities of other concerned units and agencies of government. In preparing the plan, the City involved all appropriate City departments as needed. In addition, the Waukesha County Office of Emergency Management was contacted and has been involved in cooperative planning with the City. Additionally, the development of detailed system plans as described herein involved the coordination and cooperation of many agencies and units of government, including, but not limited to, adjacent local units of government, the Milwaukee Metropolitan Sewerage District, and the Wisconsin Department of Natural Resources.

The preparation of the plan is an important step in minimizing flood damages in the City and is a condition of the City's receiving grant funding administered by the Wisconsin Department of Military Affairs, Division of Emergency Management, under the Hazard Mitigation Grant Program in conjunction with the flooding which occurred in the City in 1997 and 1998.

STUDY AREA

The study area encompassed by the plan includes 1) a primary study area coterminous with the corporate boundaries of the City of Brookfield and those portions of the two watersheds—the Fox River and Menomonee River watersheds—that lie within the City and 2) a secondary study area encompassing those portions of the two watersheds that lie outside the City but within the State of Wisconsin (see Map 1). The latter portion of the overall study area was considered because of the importance of considering floodland management planning on a watershed basis. The Fox River watershed, which encompasses a total area of about 2,582 square miles, encompasses lands within Wisconsin and Illinois. The portion of the watershed within Wisconsin encompasses about 942 square miles. The Menomonee River watershed encompasses about 136 square miles. The primary study area encompasses a total of about 26.5 square miles, or about 2 percent of the overall study area of about 1,078 square miles. The secondary study area encompasses a total of about 1,052 square miles, or the remaining approximately 98 percent of the overall study area.

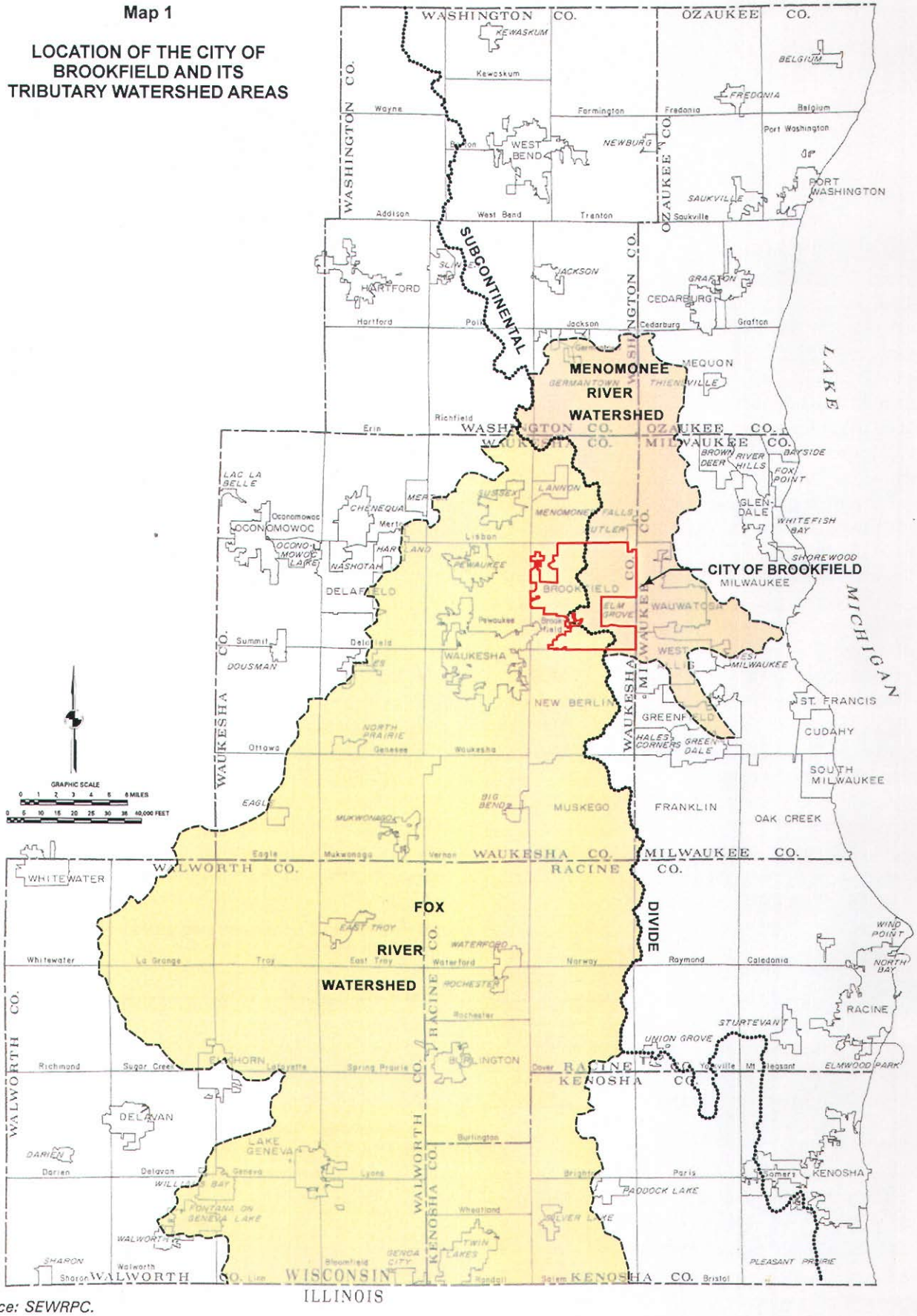
NEED FOR THE PLAN

Floodwaters can directly damage buildings and other structures in numerous ways. The most common types of damage include hydrostatic pressure leading to the collapse of building foundations, basement slab heaving, and loss of mortar; erosion of foundations and soil; heaving of sidewalks and slabs; saturation of insulation; wood rot; deterioration of masonry and concrete, including soluble salt damage and freezing and thawing damage; damage to metal structural components, including fasteners, exposed metals, and embedded iron; damage to interior finishes, including drywall, plaster, wood floors and trim, interior paint, wallpaper, and floor coverings; exterior paint problems; and damage to utilities, appliances, equipment, merchandise, and personal belongings. In addition to personal losses arising from such damage, businesses damaged by floodwater can suffer economic losses arising from being forced to suspend operations as a result of the flooding and its aftermath. In addition to direct flood damages, indirect damages, such as the cost of temporary evacuation or relocation and lost wages, as well as intangible damages, such as psychological stress and health hazards, can occur.

A number of major flooding events, including many that have caused extensive damage, have been

Map 1

LOCATION OF THE CITY OF BROOKFIELD AND ITS TRIBUTARY WATERSHED AREAS



Source: SEWRPC.

recorded within the primary and secondary planning areas since their settlement by Europeans in the 19th century. In addition to major floods in 1960, 1972, 1973, and 1986, these events have included the following:

- The event of June 20-21, 1997, when a period of moderate rainfall followed by intense thunderstorms centered in northern Milwaukee County resulted in about six inches of rain in a 26-hour period in the City of Brookfield. Flooding occurred along Underwood Creek in the City of Brookfield and the Village of Elm Grove. In addition, there were numerous occurrences of flooding of streets and stormwater drainage and sanitary sewer backup problems. It is estimated that the peak flood flows on Underwood Creek within the City of Brookfield and the Village of Elm Grove had a recurrence interval of somewhat less than 100 years.

- The event of July 2, 1997, a "follow-up" storm to the June 20-21, 1997, storm event, involved two to three inches of rain, but resulted in little additional property damage.

- The event of August 6, 1998, in which five or more inches of rain in northern Milwaukee County and northeastern Waukesha County resulted in severe stormwater drainage and flooding problems. Moderate rainfalls occurred on August 4 and 5, with daily totals of generally about one inch or less. The most intense rainfall on August 6 in the City of Brookfield. Locations that experienced severe, direct overland flooding in a second consecutive year included areas along Underwood Creek in the City of Brookfield and the Village of Elm Grove. It is estimated that about 550 residences in the City and as many as one-half of the properties in the Village suffered damages from the overflow of streams, stormwater runoff, or sanitary sewer backup. The estimated recurrence interval for the August 1998 peak flood flow on Underwood Creek within the City and the Village is close to 500 years.

The recent flooding events demonstrate the continuing need for a comprehensive and cooperative strategy for mitigating existing flooding problems and for preventing future flooding in the City of Brookfield. In the absence of adequate planning, the City may be expected to continue to experience repetitive flooding problems. A systematic plan to address existing flooding problems and avoid the creation of new problems is therefore critical to the sound development of the City.

SCOPE AND PURPOSE OF PLAN

This plan is intended to set forth the most appropriate, feasible, and effective flood mitigation strategy for the City of Brookfield. The planning process, which is also documented in this report, includes the following steps:

- Conduct of inventories and analyses of relevant basic data pertaining to the overall study area, including data on current and planned land use and related data; the surface-water system; existing applicable floodland management regulations and programs; historical flooding problems; and recent flood events and associated flooding problems.

- Identification of flood mitigation goals and objectives for the City.

- Analysis and assessment of flood problems in the City.

- Consideration of alternative flood mitigation strategies. Alternative strategies must be considered in the context of comprehensive water resource and other planning efforts, particularly recent floodland system planning efforts.

- Identification of potential funding sources for flood hazard mitigation efforts.

- Selection and description of a flood mitigation plan for the City, including 1) documentation of public participation activities and coordination efforts undertaken with other concerned "stakeholders," including other units and agencies of government and concerned private-sector parties, undertaken as part of the planning process, 2) description of recommended plan implementation strategies, and 3) description of recommended plan monitoring strategies.

The Watershed as a Planning Unit

Planning for floodland- and stormwater-related problems can conceivably be carried out on the basis of a number of different geographic units, including areas defined by governmental jurisdictions, economic linkages, or watersheds. There are important reasons for utilizing the watershed as a water resources planning unit. These reasons include the following:

- Floodland management measures, flood control measures, and stormwater management facilities should form a single integrated system over a watershed. The streams and watercourses of a watershed must be capable of carrying present and future runoff loads generated by existing and probable future land use development patterns within the watershed. Therefore, flood control and stormwater management problems can best be considered on a watershed basis.

- Flood control and stormwater drainage problems are closely related to other land and water use problems. Consequently, floodland protection and water-related park and open space preservation can be best studied on a watershed basis.

- Changes in land use and transportation requirements ordinarily are not controlled by watershed factors, but nevertheless have major effects on watershed problems. Land use and transportation system patterns significantly affect the amount and spatial distribution of hydrologic loadings to be accommodated by water control facilities. In turn, the water control facilities and their effect on historical floodlands determine to a considerable extent the uses to which certain land areas can be put.

- Finally, the related physical problems of a watershed tend to create a community interest within the watershed around which floodland and stormwater management planning efforts can be organized.

For these reasons, the watershed is a logical unit for floodland management and related stormwater management planning, provided the relationships existing between the watershed and the surrounding region are recognized. Accordingly, since its inception in 1960, the regional planning program in the Southeastern Wisconsin Region has embodied a recognition of the need to consider watersheds as rational planning units if workable solutions are to be found for interrelated land and water use problems, including flood mitigation. Also accordingly, this flood mitigation plan has included consideration of the watersheds which lie partly within the City of Brookfield, in addition to the City itself.

Relationship of Flood Control Planning to Stormwater Management Planning

While the focus of the current planning effort is flood mitigation within the City of Brookfield, it is imperative to note the importance of the relationship between flood control planning and stormwater management planning.

In both flood control and stormwater management planning, the important effect of land use development on flood flows and stages and on water quality conditions must be recognized. It is important to understand the differences between flood control and stormwater management planning. Flood control planning deals with the problems presented when peak streamflows exceed stream channel capabilities and floodwaters move outward from stream channels to occupy natural floodplains, particularly such floodplains occupied by flood-damage-prone development. Sound flood control measures for any given watershed include, first and foremost, the preservation of floodlands in essentially natural, open uses and, as may be found necessary, the provision of floodwater storage capacity above and beyond that provided by the remaining open floodlands to reduce peak flood flows along the stream channels; the removal of existing flood-damage-prone buildings and the floodproofing of other existing flood-damage-prone buildings; and, as a last resort, modifications to increase the flood conveyance capacities of the streams and watercourses, including the replacement of hydraulic control structures, such as bridges, culverts, and dams.

Stormwater management planning deals with problems created by the inability of stormwater runoff to reach the major stream channels of a watershed without attendant local ponding; street, yard, and basement flooding; and surcharging of sanitary sewerage systems with attendant basement flooding. The proper preparation of stormwater management system plans requires the existence of agreed-upon flood control system plans. This is important because the flood elevations along the major stream channels will determine the configuration, sizing, and performance of the

local drainage systems. In some cases, the design of a stormwater management system may require revisions in the flood control plan.

Both flood control and stormwater management system plans must consider the need for water pollution abatement measures to meet water use objectives and related water quality standards. At the watershed level, this requires the incorporation of areawide recommendations for the abatement of point sources of water pollution, such as sewage treatment plant discharges, and the reduction of nonpoint sources of water pollution.

Importantly, local stormwater management system planning must also be integrated with sanitary sewerage system planning in order to address the serious public health and safety problems caused by the surcharging of sanitary sewers during periods of excessive rainfall with attendant backup of sanitary sewage into basements of buildings, or the required bypassing of raw sanitary sewage to storm sewers, roadside swales and ditches, and natural swales and watercourses.

Other Hazards

Like other municipalities in Waukesha County and Southeastern Wisconsin, the City of Brookfield is vulnerable to a wide range of hazards besides flooding. As an integral part of their emergency management planning efforts, both the City and other municipalities in the County cooperate with Waukesha County in planning for, and as appropriate, responding to any disasters that may arise from flooding or other hazards.

Waukesha County has developed an emergency operations plan[1] which sets forth an all-hazards action plan. The City of Brookfield also has developed an emergency operations plan[2] which complements the County plan and which also sets forth procedures and actions to deal with a range of situations and events. Waukesha County's emergency operations plan notes that the County is exposed to many hazards that have the potential for disrupting the community, causing damage, and creating casualties. In addition to flooding, the plan recognizes that the County is vulnerable to other natural hazards, including snowstorms, tornadoes, downbursts, and other violent storms; accidents involving hazardous materials; major transportation accidents; terrorism and civil disorder; and war-related incidents, including nuclear, biochemical, or conventional attack.

It should be noted that the hazards considered by the County and City in the integrated all-hazards emergency operation plans, with the exception of flood hazards, are not geographic in nature. Accordingly, no mapping of the other hazard areas is needed.

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[1]Waukesha County, Wisconsin, Waukesha County Emergency Operations Plan: Basic Plan, *[Waukesha County, Waukesha Wisconsin], 1996.*

[2]City of Brookfield, Wisconsin, City of Brookfield Emergency Operations Plan, *[City of Brookfield, Brookfield, Wisconsin], 1999.*

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Chapter II

BASIC STUDY AREA INVENTORY AND ANALYSIS

Information on certain pertinent natural and built features and aspects of the study area is essential to sound flood mitigation planning. Accordingly, the collection and collation of definitive information regarding basic demographic characteristics, existing and planned land use, surface-water-system characteristics, environmentally sensitive areas, existing floodland management regulations and programs, historical flooding problems, and recent flood events constitute an important step in the planning process. The resulting information is essential to the planning process, since sound alternative plans cannot be formulated and evaluated without an in-depth knowledge of the relevant conditions in the study area.

POPULATION AND HOUSEHOLDS

Because of the direct relationships that exist between resident population levels and land use patterns, an inventory and analysis of the existing and anticipated 2020 resident population and household levels in the City of Brookfield, the portion of the Fox River watershed within the State of Wisconsin, and the Menomonee River watershed was performed as part of the preparation of this flood mitigation plan for the City. As indicated in Table 1, the resident population of the City is anticipated to remain stable with a modest increase from the 1995 level of about 38,000 persons to a 2020 level of about 40,000 persons, or by about 5.4 percent. The resident populations of the Wisconsin portion of the Fox River watershed and of the Menomonee River watershed are anticipated to increase during the 1995-2020 time period by, respectively, about 18.7 percent and about 7.4 percent. The combined resident population of the two watershed areas is thus anticipated to increase by about 12.9 percent during that time period.

Similarly, the anticipated rate of growth in the number of households within the City of Brookfield between 1995 and 2020 is envisioned to be lower than the corresponding anticipated rates of growth within the two watershed areas. The number of households in the City is anticipated to increase by about 9.8 percent between 1995 and 2020. A significant portion of this increase has recently occurred between 1995 and the year 2000. During that same time period, the number of households in the Wisconsin portion of the Fox River watershed is anticipated to increase by about 24.6 percent; the number of households in the Menomonee River watershed is anticipated to increase by about 11.5 percent; and the number of households in the two watershed areas combined is anticipated to increase by about 17.5 percent.

LAND USE

The existing 1995 land use pattern within the City of Brookfield is graphically set forth on Map 2. The existing 1995 land use pattern for the watershed areas that lie partly within the City of Brookfield is graphically set forth on Map 3. The areal extent of existing 1995 and planned 2020 land uses in 1) the City of Brookfield, 2) the Wisconsin portion of the Fox River watershed, and 3) the Menomonee River watershed are set forth, respectively, in Tables 2, 3, and 4.

As indicated in Table 2, residential land uses comprise the largest area within a given land use category in the City under both 1995 and planned 2020 conditions, encompassing about 44 percent of the total area of the City in 1995 and planned to encompass about 47 percent of the total area of the City in 2020. Lands in transportation, communication, and utility uses encompass the second-largest area within a given land use category in the City under both sets of conditions, encompassing about 16 percent of the total area of the City both under actual 1995 and planned 2020 conditions. Wetlands comprise the third-largest land use category under both sets of conditions, encompassing about 12 percent of the total area of the City in both cases. It is envisioned that nearly two square miles of lands currently in agricultural or open uses, encompassing about 7 percent of the total area of the City, will be converted to urban uses, mostly residential and commercial uses, by 2020.

Table 1

POPULATION AND HOUSEHOLD LEVELS WITHIN THE CITY OF BROOKFIELD AND THE WISCONSIN PORTION OF THE FOX RIVER WATERSHED, AND THE MENOMONEE RIVER WATERSHED: 1995 AND 2020[a]

Area	Population			Number of Households		
	Existing 1995	Planned 2020	1995-2020 Change	Existing 1995	Planned 2020	1995-2020 Change
City of Brookfield	37,991	40,056	2,065	13,664	15,004	1,340
Watershed Areas						
Fox River Watershed (Wisconsin portion)	300,374	356,594	56,220	109,774	136,750	26,976
Menomonee River Watershed	324,954	349,157	24,203	127,988	142,698	14,710
Total for Two Watershed Areas	625,328	705,751	80,423	237,762	279,448	41,686

[a]*For the purposes of this table, municipal and watershed boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

Source: SEWRPC.

In contrast to land use patterns within the City of Brookfield, agricultural lands comprise the largest area within a given land use category in the Wisconsin portion of the Fox River watershed as a whole (see Table 3). Agricultural lands there encompass about 50 percent of the area involved under both actual 1995 and planned 2020 conditions. Wetlands, which encompass about 11 percent of the total Wisconsin portion of the watershed under both actual 1995 and planned 2020 conditions, comprise the second-largest portion of the area within a given land use category under actual 1995 conditions and the third-largest portion under planned 2020 conditions, with the actual overall wetlands area planned to remain unchanged. Lands in residential uses, which encompass about 11 percent of the watershed portion under actual 1995 conditions and are planned to encompass about 12 percent of the area in 2020, comprise the third-largest portion of the area within a given land use category under 1995 conditions and are planned to comprise the second-largest portion within a given land use category in 2020. Woodlands comprise the fourth-largest portion of the area within a given land use category under both actual 1995 and planned 2020 conditions, in each case encompassing about 8 percent of the total area, with the actual overall woodlands area planned to remain unchanged. About 19 square miles of the watershed portion now in agricultural or open uses, or about 2 percent of the total area, are envisioned to be converted to urban uses by 2020.

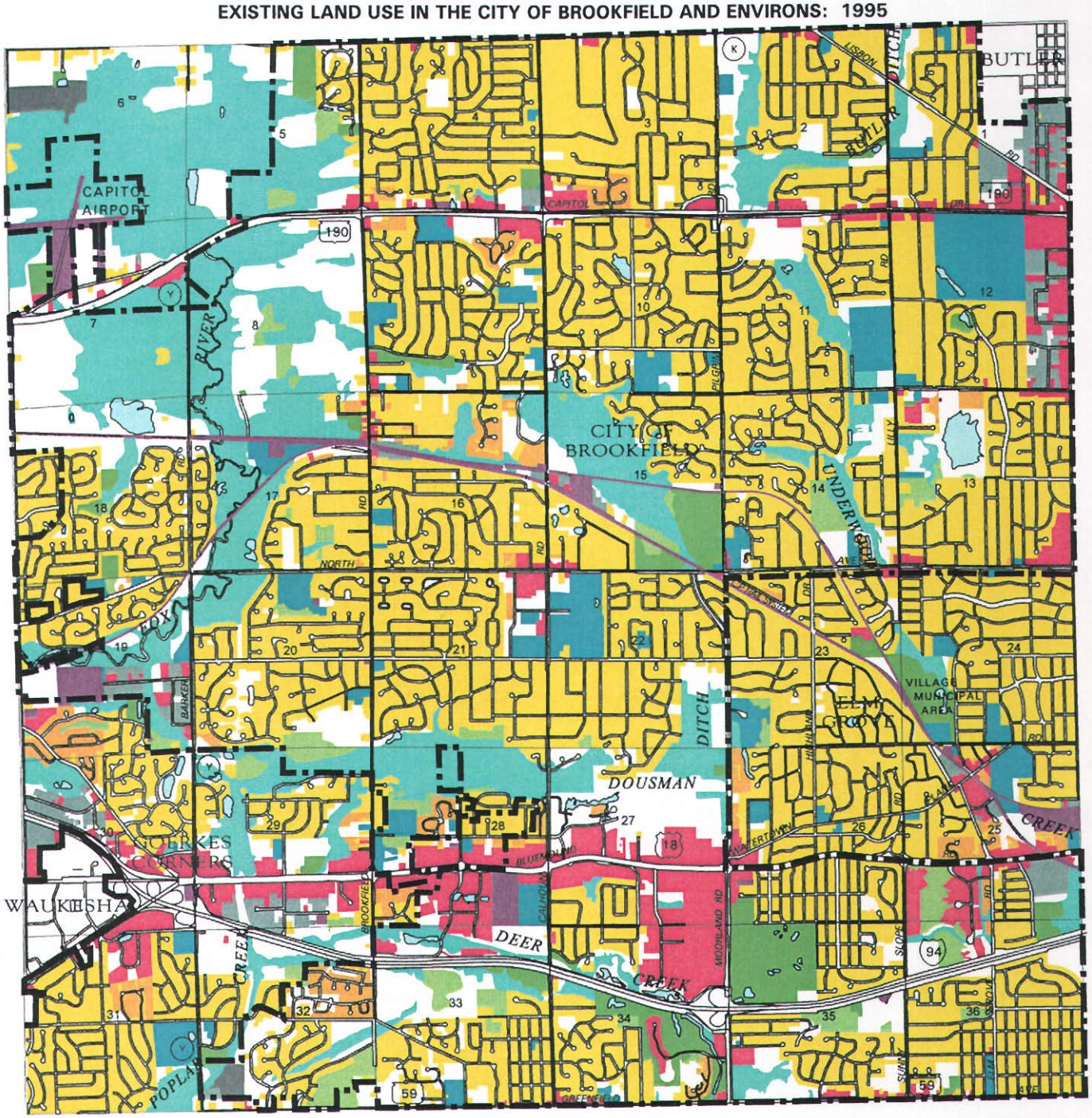
In the more urbanized Menomonee River watershed, lands in residential uses comprise the largest area within a given land use category under both actual 1995 and planned 2020 conditions, encompassing about 29 percent of the total area of the watershed in 1995 and planned to encompass about 33 percent of the watershed in 2020 (see Table 4). Agricultural lands comprise the second-largest area within a given land use category in the watershed under both sets of conditions, encompassing about 20 percent of the watershed in 1995 and planned to encompass about 18 percent of the watershed in 2020. Lands in transportation, communication, and utility uses encompass the third-largest area within a given land use category in the watershed under both sets of conditions, encompassing about 15 percent of the total area of the watershed in 1995 and planned to encompass about 16 percent of the watershed in 2020. About seven square miles of the watershed now in agricultural or open uses, or about 5 percent of the total area of the watershed, are envisioned to be converted to urban uses by 2020.

SURFACE-WATER SYSTEM

The City of Brookfield, like the seven-county Southeastern Wisconsin Region of which it is a part, is traversed by a major subcontinental divide that roughly bisects both the City and the Region. This subcontinental divide not only exerts a major physical influence upon the gross drainage pattern of the City and the Region, but also carries with it certain legal constraints pertaining to the diversion of water across the divide. The respective parts of the City and the Region lying east of this divide are tributary to the

Map 2

EXISTING LAND USE IN THE CITY OF BROOKFIELD AND ENVIRONS: 1995



- 1995 CITY OF BROOKFIELD CIVIL DIVISION BOUNDARY
- SINGLE-FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- TRANSPORTATION, COMMUNICATION, AND UTILITIES
- GOVERNMENTAL AND INSTITUTIONAL
- STREET RIGHTS-OF-WAY
- RECREATIONAL
- WETLANDS
- UPLAND WOODS
- EXTRACTIVE AND LANDFILL
- SURFACE WATER
- OPEN LANDS

GRAPHIC SCALE

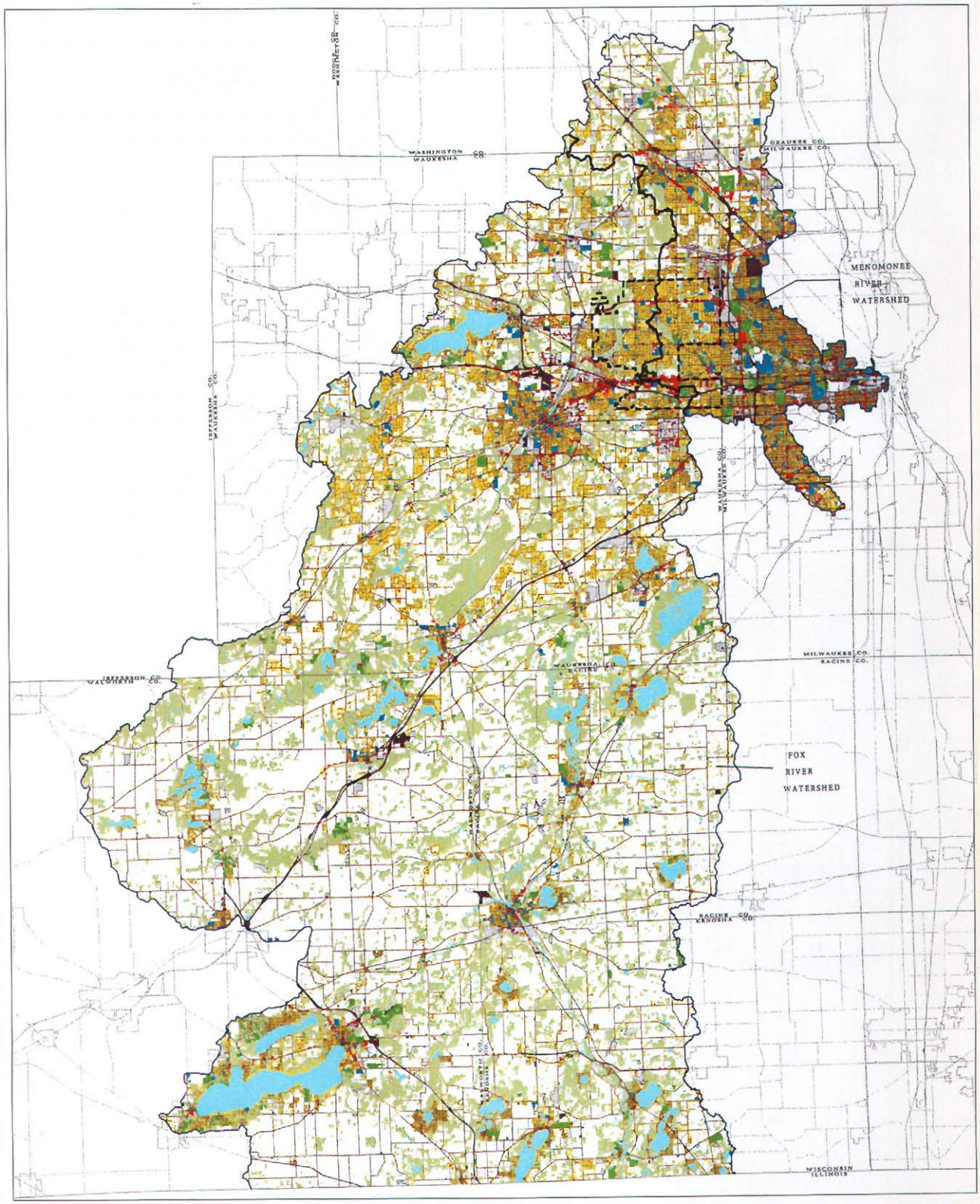
0 1/2 1 MILES

0 2000 4000 6000 FEET

Source: SEWRPC.

Map 3

EXISTING LAND USES IN THE CITY OF BROOKFIELD AND ITS TRIBUTARY WATERSHEDS: 1995



Source: SEWRPC.

Table 2

LAND USE IN THE CITY OF BROOKFIELD BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	0	0	0
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	7,299	7,465	166
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	518	944	426
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	0	0	0
Residential Subtotal	7,817	8,409	592
Commercial	957	1,428	471
Industrial	221	221	0
Transportation, Communication, and Utilities[b]	31,306	34,061	2,755
Governmental and Institutional	645	684	39
Recreational	450	487	37
Agricultural	719	411	-308
Open Lands[c]	1,528	578	-950
Wetlands	2,137	2,137	0
Woodlands	363	363	0
Surface Water	149	149	0
Total	17,735	17,735	0

[a]*For the purposes of this table, municipal and watershed boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

Great Lakes-St. Lawrence River drainage system, while the respective parts of the City and the Region lying west of the divide are tributary to the Mississippi River drainage system. The entire portion of the City of Brookfield that lies east of the divide comprises a portion of the Menomonee River watershed; the entire portion of the City that lies west of the divide comprises a portion of the Fox River watershed. Each of the two watersheds lying partly within the City, in turn, consists of a set of subwatersheds, several of which lie partly within the City in the case of both watersheds involved.

Map 4 illustrates significant streams and lakes within the boundaries of the two watershed areas that lie partly within the City of Brookfield. Details on the flood hazard areas associated with the surface waters within the City of Brookfield are presented in Chapter IV

ENVIRONMENTALLY SENSITIVE AREAS AND OPEN SPACE PRESERVATION

Many of the natural resource base elements of the City of Brookfield occur in linear concentrations on the landscape. One of the most important tasks completed under the regional planning program for Southeastern Wisconsin has been the identification and delineation of these linear areas, or corridors. The most important elements of the natural resource base and closely related features including wetlands, woodlands, prairies, wildlife habitat, major lakes and streams and associated shoreland and floodlands, and historic, scenic, and recreational sites, when combined, result in an essentially linear pattern referred to

Table 3

LAND USE IN THE WISCONSIN PORTION OF THE FOX RIVER WATERSHED BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	5,118	5,140	22
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	41,105	45,313	4,208
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	16,864	18,446	1,582
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	793	793	0
Residential Subtotal	63,880	69,692	5,812
Commercial	3,724	5,110	1,386
Industrial	3,676	5,727	2,051
Transportation, Communication, and Utilities[b]	31,306	34,061	2,755
Governmental and Institutional	3,924	3,995	71
Recreational	9,277	9,629	352
Agricultural	301,068	298,583	-2,485
Open Lands[c]	37,205	27,263	-9,942
Wetlands	68,622	68,622	0
Woodlands	50,030	50,030	0
Surface Water	25,930	25,930	0
Total	598,642	598,642	0

[a]*For the purposes of this table, municipal and watershed boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

by the Regional Planning Commission as environmental corridors. Primary environmental corridors include a wide variety of important natural resource and related elements and are, by definition, at least 400 acres in size, two miles long, and 200 feet wide. Secondary environmental corridors generally connect with the primary environmental corridors and are at least 100 acres in size and one mile in length. In addition, smaller concentrations of natural resource base elements that are separated physically from the environmental corridors by intensive urban or agricultural land uses have also been identified. These areas, which are at least five acres in size, are referred to as isolated natural resource areas.

In any consideration of environmental corridors and important natural features, it is important to note that the preservation of such features can assist in the attenuation of flood flows. The drainage of wetlands, which are included in the corridors and natural resource areas, may destroy natural filtration and floodwater storage areas. In addition, the intrusion of intensive urban land uses into such areas may result in the creation of serious and costly problems, such as failing foundations for pavements and structures, wet basements, excessive operation of sump pumps, excessive clearwater infiltration into sanitary sewerage systems, and poor drainage. Similarly, destruction of ground cover may result in soil erosion, stream siltation, more rapid runoff, and increased flooding , as well as the destruction of wildlife habitat.

Although the effects of any one of these environmental changes may not in and of itself be overwhelming, the combined effects must eventually lead to a serious deterioration of the underlying and sustaining natural resource base and of the overall quality of the environment for life. The need to maintain the integrity of the remaining environmental corridors and

Table 4

LAND USE IN THE MENOMONEE RIVER WATERSHED BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	226	226	0
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	10,622	12,897	2,275
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	8,040	8,428	388
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	6,479	6,607	128
Residential Subtotal	25,367	28,158	2,791
Commercial	3,076	3,581	505
Industrial	3,949	4,496	547
Transportation, Communication, and Utilities[b]	13,224	13,625	401
Governmental and Institutional	3,708	3,817	109
Recreational	3,311	3,484	173
Agricultural	17,194	15,837	-1,357
Open Lands[c]	7,248	4,079	-3,169
Wetlands	6,656	6,656	0
Woodlands	2,140	2,140	0
Surface Water	509	509	0
Total	86,382	86,382	0

[a]*For the purposes of this table, municipal and watershed boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

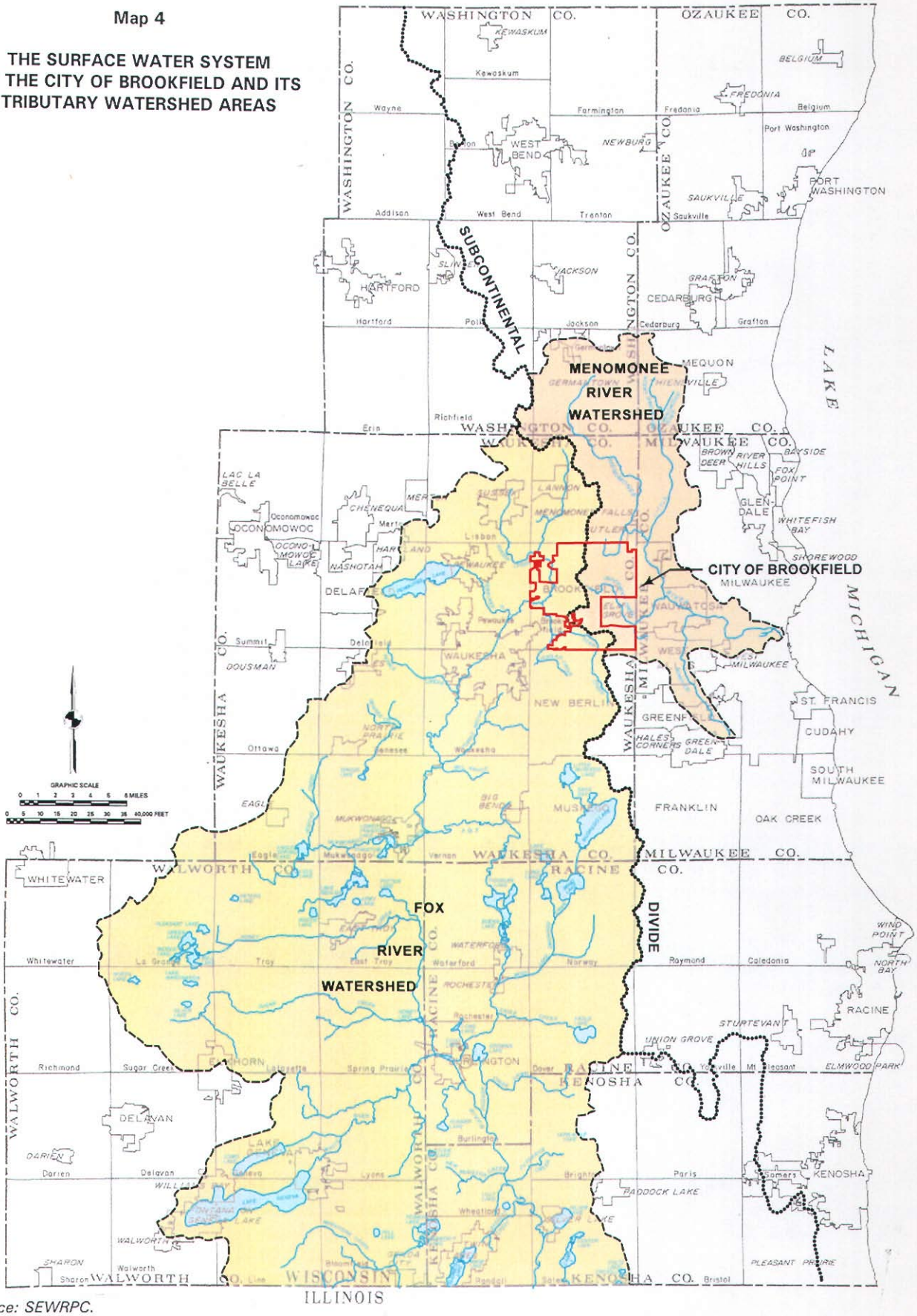
isolated natural resource areas in the City of Brookfield should thus be apparent. The location and extent of the environmental corridors and isolated natural resource areas in the City is shown on Map 5.

The City of Brookfield has taken an active role in preserving the environmental corridors and isolated natural resource areas within the City as part of its park and open space planning program.[1] Under full implementation of the park and open space plan for the City of Brookfield, the important natural resource features in the City would be protected and preserved for resource preservation and other open space purposes, as shown on Map 6. That plan included specific consideration of the lands within the study area, including the Village of Elm Grove and the Town of Brookfield, as well as the City of Brookfield. Such preservation will provide many benefits to the community, including a reduction in flood damage, soil erosion, and storm water runoff, and protection of wildlife habitat. Such benefits enhance the quality of life for City residents. It is further recommended that Waukesha County continue to acquire lands within the Fox River environmental corridor and that the Village of Elm Grove and the Town of Brookfield acquire environmentally sensitive lands within their municipal boundaries, as shown on Map 6. Table 5 presents a summary of the number of acres to be acquired and the estimated acquisition cost, assuming all property is purchased outright rather than dedicated.

[1]*Preliminary draft, July 2000, SEWRPC Community Assistance Planning Report No. 108, 2nd Edition,* A Park and Open Space Plan for the City of Brookfield: 2020, Waukesha County, Wisconsin.

Map 4

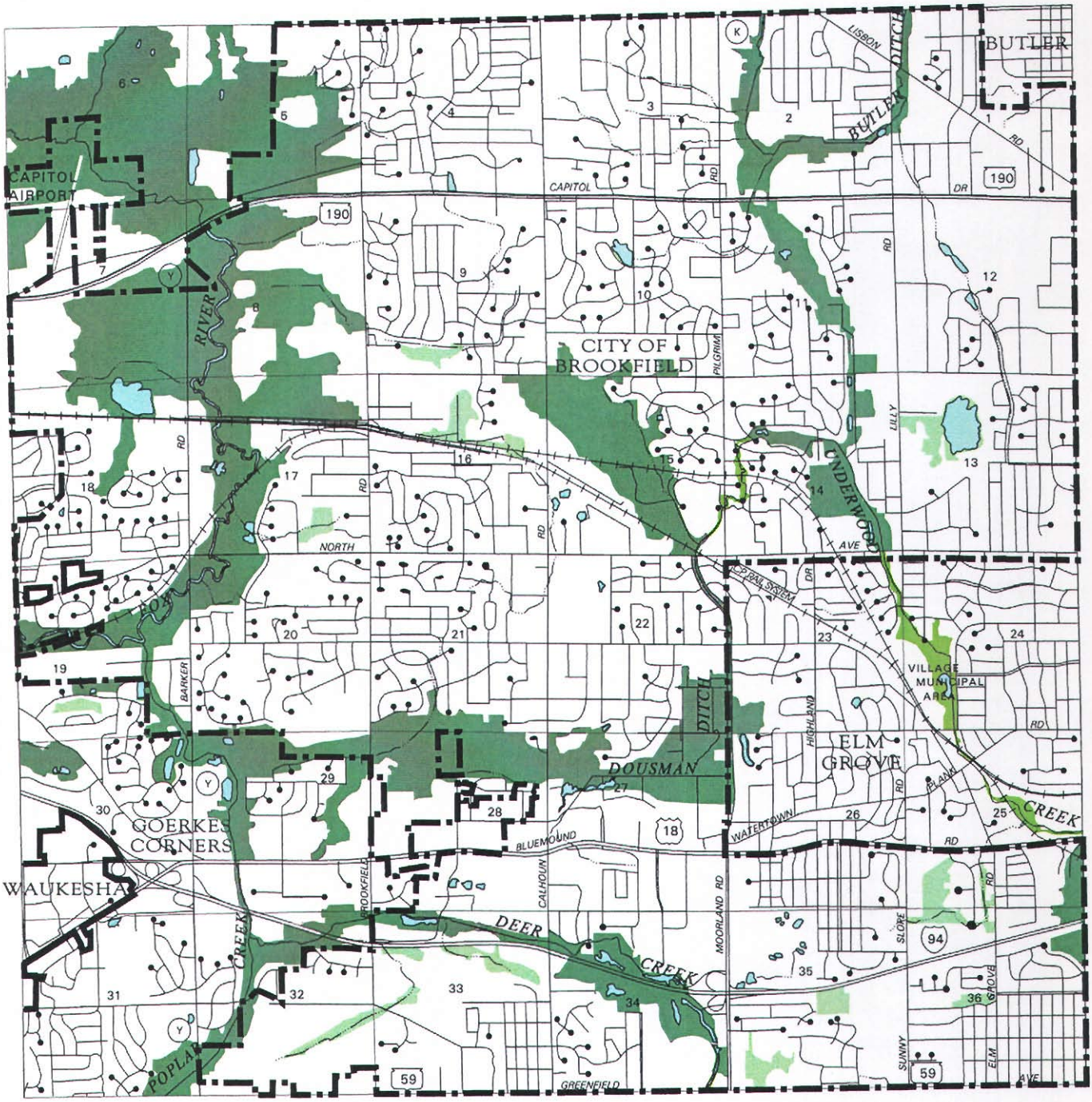
THE SURFACE WATER SYSTEM OF THE CITY OF BROOKFIELD AND ITS TRIBUTARY WATERSHED AREAS



Source: SEWRPC.

Map 5

ENVIRONMENTALLY SIGNIFICANT LANDS IN THE CITY OF BROOKFIELD AND ENVIRONS



PRIMARY ENVIRONMENTAL CORRIDOR

SECONDARY ENVIRONMENTAL CORRIDOR

ISOLATED NATURAL RESOURCE AREA

SURFACE WATER

1995 CITY OF BROOKFIELD CIVIL DIVISION BOUNDARY

GRAPHIC SCALE

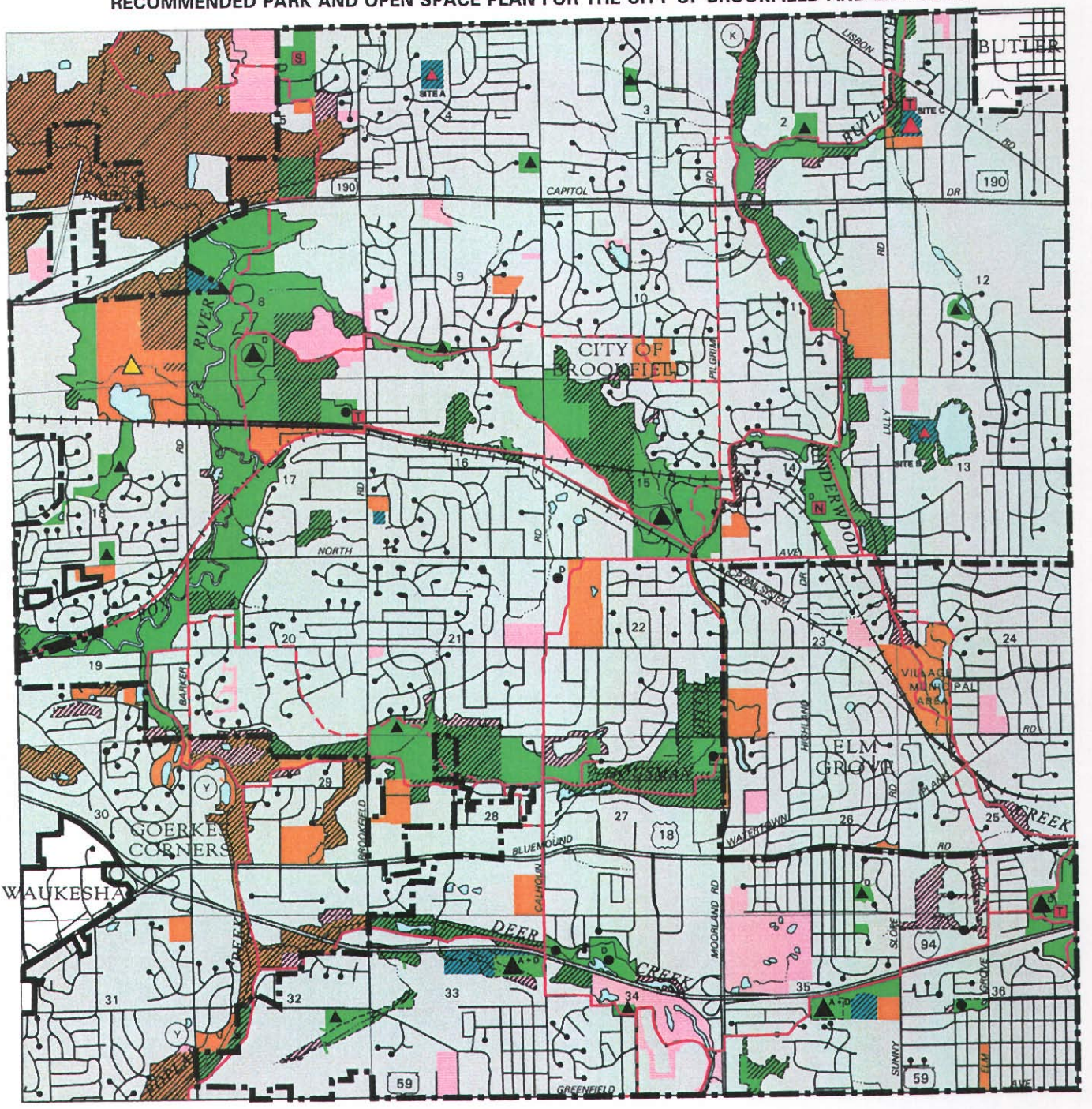
0 1/2 1 MILES

0 2000 4000 8000 FEET

Source: SEWRPC.

Map 6

RECOMMENDED PARK AND OPEN SPACE PLAN FOR THE CITY OF BROOKFIELD AND ENVIRONS



URBAN DEVELOPMENT

OPEN SPACE PRESERVATION ELEMENT
NATURAL RESOURCE FEATURES

- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA

OWNERSHIP

- EXISTING CITY OWNERSHIP: OPEN SPACE PRESERVATION OR OUTDOOR RECREATION USE
- PROPOSED CITY OWNERSHIP: OPEN SPACE PRESERVATION
- PROPOSED CITY OWNERSHIP: OUTDOOR RECREATION USE
- EXISTING OTHER PUBLIC OWNERSHIP: OPEN SPACE PRESERVATION, SCHOOL, OR OUTDOOR RECREATION USE
- PROPOSED OTHER PUBLIC OWNERSHIP: OPEN SPACE PRESERVATION OR OUTDOOR RECREATION USE
- EXISTING PRIVATE OWNERSHIP: OUTDOOR RECREATION USE OR PRIVATE SCHOOL
- EXISTING PRIVATE OWNERSHIP: OPEN SPACE PRESERVATION THROUGH PUBLIC LAND USE REGULATION

OUTDOOR RECREATION ELEMENT
PARK OR OUTDOOR RECREATION SITE

- EXISTING MAJOR COUNTY PARK
- EXISTING CITY OWNERSHIP: MAJOR OR COMMUNITY PARK
- EXISTING CITY OWNERSHIP: DISTRICT PARK
- PROPOSED CITY OWNERSHIP: DISTRICT PARK
- EXISTING CITY OWNERSHIP: NEIGHBORHOOD PARK OR PLAYFIELD
- PROPOSED CITY OWNERSHIP: NEIGHBORHOOD PARK
- EXISTING CITY OWNERSHIP: SPECIAL PARK
- S EXISTING CITY OWNERSHIP: SOCCER PARK
- N EXISTING CITY OWNERSHIP: NATURE CENTER
- A ADDITIONAL ACQUISITION RECOMMENDED
- D ADDITIONAL DEVELOPMENT RECOMMENDED

RECREATION TRAIL

- PROPOSED CITY TRAIL
- INTERIM OR ALTERNATE CITY TRAIL ROUTE
- T PROPOSED CITY TRAIL ACCESS SITE
- PROPOSED FOX RIVER COUNTY TRAIL

GRAPHIC SCALE
0 1/2 1 MILES
0 2000 4000 6000 FEET

Source: City of Brookfield and SEWRPC.

Table 5

PROPOSED OWNERSHIP OF OPEN SPACE LANDS[a] UNDER THE CITY OF BROOKFIELD PARK AND OPEN SPACE PLAN

Ownership	Existing[b] (acres)	Plan (acres)	Planned Change (acres)	Estimated Acquisition Cost[c]
City of Brookfield	1,407	2,347	940	$ 9,417,000
Other Public[d]	361	1,577	1,216	5,905,000
Compatible Private[e]	385	385	--	--
Total	2,153	4,309	2,156	$15,322,000

NOTE: Cost estimates are expressed in 2000 dollars.

[a]Includes planned primary environmental corridors, planned secondary environmental corridors, planned isolated natural resource areas, and floodlands outside corridors proposed to be acquired.

[b]Includes existing ownership in 1999.

[c]Unit costs used to estimate acquisition costs were $1,000 per acre of wetlands, $35,000 per acre of woodlands, and $30,000 per acre of open lands.

[d]Includes Waukesha County, the Village of Elm Grove, the Town of Brookfield, and the Elmbrook School District.

[e]Includes open space lands held in private ownership for recreational use (for example, golf courses, driving ranges, and athletic fields owned by private schools and organizations) and private lands owned by homeowner's associations or other entities for resource protection purposes.

Source: City of Brookfield and SEWRPC.

It is recognized, however, that in some cases privately owned outdoor recreation sites or private land in open space uses can serve to protect environmentally sensitive lands. Examples of the latter include privately owned parcels or development sites where a portion of the parcel or site is located in a woodland or wetland. If public acquisition is not possible or practical, the plan recommends that such areas be maintained in open space for resource preservation purposes and that such maintenance be ensured through conservancy zoning and, where appropriate, deed restrictions.

Primary Environmental Corridors

The planned primary environmental corridors encompass approximately 2,816 acres, or about 16 percent of the City of Brookfield. The primary environmental corridors are located along the Fox River and other major streams and wetland complexes within the City. Under the plan, all primary environmental corridors would be preserved in essentially natural, open uses.

As of 1999, the City owned about 1,332 acres of primary environmental corridor lands. Under the park and open space plan, an additional 824 acres of primary environmental corridor lands would be acquired by the City, for a total of 2,156 acres. This represents approximately 77 percent of all primary environmental corridors within the City. In addition, Waukesha County would own about 295 acres within the Fox River primary environmental corridor within the City, resulting in about 87 percent of primary environmental corridor lands in the City owned by the City or County.

Secondary Environmental Corridors

Planned secondary environmental corridors encompass approximately 17 acres within the City of Brookfield. All secondary environmental corridors in the City are located along Underwood Creek in Section 14 just east of Wirth Park. Land within this secondary corridor is proposed to remain in private ownership and protected through zoning.

Isolated Natural Resource Areas
Isolated natural resource areas encompass approximately 276 acres in the City of Brookfield. Of these 276 acres, 76 acres are currently owned by the City. An additional 135 acres are proposed to be acquired by the City, for a total of 211 acres, or 76 percent of lands within isolated natural resource areas, under City ownership. The remaining 65 acres are proposed to remain in private ownership and protected through zoning.

Preservation of Wetlands
A wetland preservation plan was adopted as an element of the first edition of the park and open space plan. The wetland preservation plan was prepared under the guidance of the Wetlands Management Task Force, formed in 1989 by the City of Brookfield Plan Commission. The recommendations of the wetland preservation plan have been incorporated into the park and open space plan update.

The plan recommends that all wetlands within primary environmental corridors and all additional wetlands of five acres or larger outside primary environmental corridors be protected, generally through public acquisition. Of the 3,202 acres of wetlands within the study area, 1,099 acres are protected through existing City ownership and an additional 191 acres are protected through existing County, Village, or Town ownership.

The plan recommends that the City acquire about 673 additional acres of wetlands. Waukesha County is recommended to acquire remaining wetlands within the Fox River corridor, the Village of Elm Grove is recommended to acquire the wetland area north of and adjacent to the Village park, and the Town of Brookfield is recommended to acquire wetlands within the primary environmental corridor along Deer and Poplar Creeks within the Town, for a total of 1,055 acres. Under the plan, a total of 3,019 acres, or 94 percent of the wetlands within the park and open space plan study area, would be protected through public ownership.

Preservation of Woodlands
The woodland preservation plan recommends that woodlands within primary environmental corridors be preserved. There are 15 such woodlands encompassing 140 acres in the study area, with 12 woodlands encompassing 119 acres within the City.

Preservation of Floodlands
Floodlands are not well suited to urban development due to flood hazards, high water tables, and soils generally not suited to urban uses. The City park and open space plan recommends that floodlands be preserved and protected in essentially natural, open space uses, including parks and parkways. It should be noted that certain outdoor recreation facilities may be suitable for development in floodland areas not covered by wetlands or areas of unsuitable soil. Such lands may accommodate playfields, playgrounds, or trails. Development of any facilities within floodlands should be carefully evaluated on a site-specific basis, with consideration given to natural resource concerns, as well as the effects of periodic flooding on the use of the facilities being considered.

The wetland preservation plan presented in the first edition of the park and open space plan includes recommendations for the protection of areas within the 100-year recurrence interval floodplain, termed floodlands, within the primary environmental corridor. Wetlands located in floodlands are protected under the wetland preservation plan. Recommendations for the protection of floodlands that are not covered by wetland vegetation, such as floodlands in agricultural production, are set forth in an appendix of the first edition of the park and open space plan and are included herein as Appendix A. The plan calls for the acquisition of such floodlands, recognizing that floodlands in an urbanizing area formerly used for agricultural purposes, if left undeveloped, will revert to wetlands and provide flood storage and other benefits. The plan further calls for acquired floodlands to be restored to wetlands. The Wetlands Management Task Force did, however, determine that an easement held by the City providing for public access and permitting construction of flood control structures and conduct of other flood control measures could be considered an acceptable substitute for fee-simple acquisition of the lands concerned.

In 1989, there were about 600 acres of primary environmental corridor lands consisting of nonwetland floodlands in the park and open space plan study area, of which 391 acres were located in the City. Such floodlands were located adjacent to the Fox River corridor in the western portion of the study area, along Poplar Creek in the southwestern portion of the study area, along Deer Creek and Dousman Ditch in the

south-central portion of the study area, and along Butler Ditch in the northeast portion of the study area.

Of the 391 acres of nonwetland floodlands within primary environmental corridors in the City, about 146 acres are in City parks or open space sites, about five acres are in Fox Brook County Park, and an additional 40 acres are in compatible private recreation use (Brookfield Hills Golf Course), as of 1999. As shown on Map 6, the park and open space plan recommends that the balance of about 200 acres be acquired by the City. That plan also reflects a recommendation from the stormwater management plan for the Dousman Ditch and Underwood Creek subwatersheds that an area adjacent to the primary environmental corridor near the intersection of North Avenue and Lilly Road be acquired by the City for floodwater storage.

Of the approximately 200 acres of nonwetland floodlands in the remainder of the park and open space plan study area, about 23 acres are owned by the Town of Brookfield within Brook Park and Marx Park. It is recommended that the Town acquire all remaining primary environmental corridor lands, including floodlands, along those portions of Deer Creek and Poplar Creek within the Town. It is further recommended that Waukesha County acquire primary environmental corridor lands along the Fox River in the northwestern portion of the study area, which include approximately 142 acres of nonwetland floodlands.

FLOODLAND MANAGEMENT REGULATIONS AND PROGRAMS

Floodland management regulations and programs perform critical roles toward assuring that flood mitigation efforts are properly implemented. The City of Brookfield currently has several pertinent regulations and programs, most notably in the form of City zoning regulations and other ordinances, wetland and floodland preservation plans, and City floodland and stormwater management programs.

Floodplain Zoning Ordinance

The City has enacted a floodplain district zoning ordinance which intended to preserve floodwater conveyance and storage capacity of floodplain areas and to prevent the location of new flood-damage-prone-development in flood hazard areas. The stated purpose of the ordinance is "to provide a uniform basis for the preparation, implementation and administration of sound floodplain regulations for Brookfield's community floodplains to prevent flood damages to persons and property; to further the maintenance of safe and healthful water conditions; to prevent and control erosion, sedimentation and other pollution of surface waters; to minimize expenditures for flood relief and flood control projects and to minimize business interruptions." Under the ordinance, designated floodplain areas within the City are divided into three districts: 1) a floodway district, which consists of the channel of any stream and those portions of the floodplain adjoining the channel that are required to carry and discharge floodwaters or flood flows of any river or stream associated with the regional flood; 2) a flood fringe district, consisting of that portion of the floodplain between the regional flood limits and the floodway area; and 3) a general floodplain district, consisting of the land which has been or may be hereafter covered by floodwater during the regional flood and encompassing both the floodway and flood fringe districts. The ordinance defines a "regional flood" as "[a] flood determined to be representative of large floods known to have generally occurred in Wisconsin and which may be expected to occur on a particular stream because of like physical characteristics," and which in any given year has a 1 percent chance of occurring or being exceeded. Within the three districts, all uses not listed as permitted uses are prohibited.

The ordinance generally prohibits any development within designated areas in cases where any such development would either 1) be vulnerable to significant damage from flooding or 2) cause a flood-stage or water-surface-profile increase of 0.01 foot or more. Under the ordinance, developments in designated flood fringe areas may not materially affect the storage capacity of floodplains. In designated floodway areas, open space uses having a low flood damage potential and which do not obstruct flood flows, such as agricultural, nonstructural commercial, recreational, railway, street, bridge, pipeline, and other water-related uses, are generally permitted. In designated flood fringe areas, certain uses, including residential, commercial, manufacturing and industrial, materials storage and processing, utility, and sewage disposal uses, are permitted under certain conditions, including conditions pertaining to structural floodproofing and other measures designed to mitigate or prevent damage arising from flooding. The ordinance restricts uses in the flood fringe to those which do not have a negative impact on the floodplain storage capacity.

Wetland Preservation Zoning

The City has also enacted a wetland preservation zoning ordinance. The stated purpose of this ordinance includes the maintenance of the stormwater and floodwater storage capacity of wetlands and the prohibition of certain land uses detrimental to wetland areas. The ordinance creates a wetland preservation district 1) including, but not limited to, all shoreland wetlands five acres or greater in area shown on the final January 31, 1986, Wisconsin Wetland Inventory Map for the City, and 2) including all lands indicated on the City's June 18, 1991, topographic wetland preservation and upland conservancy zoning maps. The ordinance divides the wetland preservation district into two subdistricts: 1) a shoreland wetland subdistrict, consisting of all defined shoreland wetlands within the City, and 2) a nonshoreland wetland subdistrict. Shoreland wetlands are defined as wetlands that are five acres or greater in area and that are located either 1) within 1,000 feet of the ordinary high-water mark of navigable lakes, ponds, or flowages or 2) within 300 feet of the ordinary high-water mark of navigable streams, or to the landward side of the floodplain, whichever distance is greater. Nonshoreland wetlands are defined as wetlands that are either 1) not designated as shoreland wetlands or 2) located within a primary environmental corridor delineated under the City's park and open space plan, or located outside a primary environmental corridor, in which case the wetland complex involved must encompass at least five acres in area, without regard to property lines or corporate limit lines. The wetland preservation district is treated and administered as an overlay district. The ordinance essentially seeks to protect all designated wetland areas from intensive development. For the purposes of providing overlay zoning for shoreland portions of City-annexed areas, the City ordinance incorporates certain sections of the Waukesha County shoreland-floodland protection ordinance that were in effect on the effective date of a particular annexation that involves shoreland, with modifications designed mainly to render the language of the County ordinance suitable for implementation by the City.

Wetland and Floodplain Preservation Planning

As previously discussed, the City of Brookfield has developed specific plans for preserving wetlands and floodlands in the City. A copy of these plans is included in Appendix A.

Stormwater Management Ordinance

As of June 2000, the City of Brookfield was in the process of finalizing a stormwater management ordinance which is expected to be adopted by the City later in the year. That ordinance provides for procedures to control the adverse impacts of stormwater runoff and ensure and protect the adequacy of the existing drainage facilities to store and convey water. The ordinance provisions are designed to mitigate the adverse impacts of new land use development and redevelopment on the quantity and quality of stormwater runoff.

Other Related Ordinances and Regulations Programs

Through a series of municipal ordinance provisions, the City seeks to control discharges to the municipal separate storm sewer system and to limit the storage and alteration to floodprone and important stormwater drainage areas. Because of the relationship between floodland and stormwater management, these regulations are mentioned here in summary form. The City seeks to control the contribution of pollutants to the municipal separate storm sewer system 1) by requiring that landfills have no substantial adverse effects on public health, welfare, and safety; 2) by prohibiting certain public nuisances affecting public health, including the pollution of waterbodies by industrial wastes; property uses that cause noxious or unwholesome liquid to flow into any roadway, sidewalk, or public place; and the storage of junk, waste matter, and garbage; and 3) by zoning regulations that, in zoning categories other than those where outdoor storage is permitted, prohibit outdoor storage that would adversely affect property values and neighborhood desirability; that prohibit storage, debris, and refuse in setback or offset areas; that limit removal of vegetation in the City's upland conservancy district; that prohibit certain uses that could produce nonpoint source pollution; that prohibit storage of materials injurious to water quality, as well as the location of solid and hazardous waste disposal sites in floodway areas; that prohibit solid waste disposal sites in flood fringe areas; that seek to prevent and control pollution of navigable waters through wetland preservation; that prohibit the removal of vegetation and land-disturbing activities in the City's upland preservation district; that prohibit land from being subdivided and served by septic tanks where soils are unsuitable; and that encourage the use of existing open channels whenever possible. The City has also enacted a construction site erosion control ordinance based on a State model ordinance.

Flood Hazard Area Documentation

The floodplains in the City of Brookfield are currently delineated and mapped as documented in the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) dated August 1986. During 1998, the City, working under a cooperative program with Waukesha County, prepared up-to-date large-scale digital topographic mapping for the entire City. The City has also contracted with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) to update all of the hydrologic-hydraulic analyses for the floodplain areas in the City. This updating will incorporate the topographic mapping as changes in the physical system, such as bridges and roadway cross-sections, and will develop detailed study of these reaches where approximate floodplain delineations are currently in place. The findings and results of this work effort will then be provided to FEMA with the objective of initiating a cooperative effort to update the FIS study and mapping. This work should serve to improve the FIS program in the City.

The flood hazard areas within the City of Brookfield are described in Chapter IV.

Ongoing Floodland Management Programs

In addition to the ordinance provisions and program noted above, the City of Brookfield engages in ongoing stormwater and floodland management programs through the activities of its Citywide Flood Task Force and of the City of Brookfield-Village of Elm Grove Underwood Creek Flooding Task Force. Both of these task forces were formed in 1998 following the major flood event in August of that year. As noted in Chapter III of this report, the City Common Council authorized the creation of the Citywide Flood Task Force to research problems, identify needs, and present policy recommendations that would provide direction to present and future stormwater planning initiatives for the City. The Task Force issued a draft initial report and recommendations in 1999. The Underwood Creek Task Force, designed to be a cooperative effort between the City of Brookfield and the Village of Elm Grove, has, with the City of Brookfield Citywide Flood Task Force, played a key role in the preparation of a comprehensive stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds in the City and the Village. This plan has recently been completed by SEWRPC and the private engineering and land surveying firm Ruekert & Mielke, Inc., in cooperation with the City, the Village, and the Wisconsin Department of Natural Resources. In their preparation of the plan, these five parties have had numerous opportunities to obtain public comments regarding problems that were experienced and to provide to the public information developed under the planning effort regarding solutions to flooding and stormwater management problems in the City and the Village. The main forums through which information was obtained from the public and through which the plan was discussed during its development were the regular meetings of the two task forces. Presentations were also made at several informational meetings for City and Village officials and the general public. Between April 28, 1997, and November 29, 1999, inclusive, nearly 20 public meetings regarding the plan were held.

In addition to the detailed floodland management planning for the Dousman Ditch and Underwood Creek area, the City has initiated similar planning for the other floodprone areas of the City.

The City has also engaged in informational and educational efforts oriented toward local homeowners and designed to help mitigate damages caused by stormwater flooding and sanitary sewer backups. These efforts include, for example, the preparation and distribution of a self-help guide for local property owners (see Appendix B). The guide sets forth potential causes of basement flooding, potential preventive measures that may be taken by homeowners, and information regarding potential actions that homeowners might take after flood damage occurs to a residence. Other informational and educational materials have been prepared and distributed as part of these efforts. This information and education program is an important component of the City's efforts toward resolving the flooding and related stormwater drainage and sanitary sewer backup problems in the City.

The alternative and selected floodland management measures developed by the two aforementioned task forces, including those developed under the Dousman Ditch-Underwood Creek plan and the public information and education program, are described in Chapters V and VII of this report.

CITY OF BROOKFIELD MASTER PLAN

In 1999, the City of Brookfield completed a master plan[2] which sets forth citywide recommendations for development and redevelopment in the City and for strategic investments in public infrastructure and resources. That plan's recommendations are set within the context of the previously discussed regional land use plan, regional and local park and open space protection plans, and flood control and stormwater management programs. In addition, that plan includes specific goals and objectives for resolving stormwater and flooding problems. These goals and objectives are described in Chapter III.

HISTORICAL FLOODING PROBLEMS

As noted in Chapter I of this report, a number of major flooding events, including several that caused significant damage, have been recorded in the area now encompassed by the City of Brookfield, as well as in the watershed areas partly encompassed within that area, since the areas involved were settled by Europeans in the 19th century. The earliest major flood event of record within either watershed area for which any significant amount of information is available is that of March 1897, which involved inundation along an approximately 1.7-mile-long reach of the Menomonee River beginning just north of present-day W. Wisconsin Avenue in Milwaukee County and extending downstream into the Menomonee River industrial valley. A June 1917 flood affected essentially the same area, and in addition caused problems farther upstream along the Menomonee River and Honey Creek. The areas for which flood problems were reported correlated with the extent of urban development in the watershed, which by 1917 generally extended as far west as Wisconsin State Fair Park. No flooding problems were reported in the area of the present-day City of Brookfield, which was incorporated in 1954. A July 1938 flood in the Wisconsin portion of the Fox River watershed was caused by a rainfall event centered over the Village of Williams Bay in Walworth County. This event, however, apparently did not cause any significant flooding in the area of the present-day City of Brookfield.

Another major flood event in the Menomonee River watershed occurred in June 1940. This event apparently approached but did not equal the severity of the June 1917 flood, inundating and causing damage to areas primarily along the Menomonee River with scattered occurrences of flooding also reported along Honey Creek, Underwood Creek, and the Little Menomonee River. Some of the reported problem areas were located west and north of the limits of urban development within the area as of 1940. The occurrence of reported flood problems outside of the urban area is attributable to the fact that the rural-area problems involved primarily damage to and the closing of river crossings and riverine-area roadways. At the Milwaukee-Waukesha county line, Underwood Creek flowed onto and closed a segment of W. Blue Mound Road (USH 18), an area that currently includes portions of the Cities of Brookfield and Wauwatosa and the Village of Elm Grove.

In late March and early April 1960, serious flooding occurred in both watershed areas as the result of a snowmelt-rainfall event. This flood, the first major flood event in which serious flood damages occurred in the Waukesha County portion of the Menomonee River watershed, caused widespread damage in low-lying areas along the Menomonee River in Milwaukee and Waukesha Counties and along Underwood Creek in Waukesha and Milwaukee Counties. Serious flooding occurred along Honey Creek in the City of West Allis as a result of the March-April 1960 flood event. An August 1960 flood event also caused serious flooding within the Honey Creek subwatershed, but the flooding involved in that event was limited to that subwatershed.

Virtually all of the serious flooding along Underwood Creek arising from the March-April 1960 event occurred within the Village of Elm Grove. In the Village, inundation and damage were reported along a 1.7-mile-long reach of the Creek extending from the Waukesha-Milwaukee county line upstream to the northern end of Village Park. The Village business district, clustered around the crossing of Watertown Plank Road over Underwood Creek, was severely damaged. There was no flooding reported along Underwood Creek upstream of the Village, in the City of Brookfield. In the Wisconsin portion of the Fox River watershed, however, several roadway segments, including some that in 1960 were located within the Town of Brookfield but which at present are located wholly or partly within the City of Brookfield, were

[2] *Cunningham Group,* City of Brookfield Year 2020 Master Plan, *December 1999.*

closed to traffic as a result of the flooding. A total of about $1,800 in private-sector damages, including about $1,600 in damage to one residence and $200 in damage to one farm property, was reported to have occurred within the City as a result of the flooding in the Fox River watershed.

A July 1964 rainfall event in the Menomonee River watershed resulted in damage limited primarily to scattered nuisance situations along the Menomonee River and more serious flooding along Honey Creek, primarily in the City of West Allis. Flooding problems were confined to the urban portion of the watershed.

A September 1972 flood event caused by a relatively large quantity of rainfall occurring under high antecedent moisture conditions affected the main stem of the Menomonee River and the area along Honey Creek in Milwaukee County and low-lying areas along Underwood Creek in the Village of Elm Grove and the City of Wauwatosa. Problems resulting from this flood involved mainly closed roadways and flooded basements and were confined primarily to urban areas, with no serious agricultural flood damages reported.

An April 1973 major flood event resulted from moderate rainfall volumes occurring over the entire Menomonee River watershed under very wet antecedent moisture conditions. Although the event caused flood problems throughout most of the urban area of the watershed, which at the time of the event encompassed about 54 percent of the total area of the watershed, the damage and disruption arising from the event were most serious along Underwood Creek in the Village of Elm Grove and along the Menomonee River in the City of Wauwatosa. In the City of Brookfield, much of the 2.65-mile-long segment of Underwood Creek lying within the City overflowed its banks. Similar floodplain inundation occurred along all of the 2.38-mile-long reach of Butler Ditch in the City and scattered examples of floodplain inundation were reported along a 2.56-mile-long portion of Dousman Ditch within the City. Relatively few structures incurred damages as a result of the flooding, but had the flood stages along the three streams been one to two feet higher, a large number of private residences would have been affected due to the topography in the area. The most serious flooding problems in the City occurred along Underwood Creek between Pilgrim Road and Clearwater Drive.

An August 1986 storm event centered in a one- to four-mile-wide band extending northwesterly from the City of Oak Creek through General Mitchell International Airport to the northern portion of the City of Wauwatosa near Lawrence J. Timmerman Airport resulted in a storm total rainfall of 6.84 inches in 24 hours, the single-day record at the airport's recording station. Flooding occurred not only in known floodplains, but also in areas where sheet flow over yards, streets, and alleys carried stormwater around and into structures and surcharged storm and sanitary sewerage systems, causing backup of stormwater and sanitary sewage into buildings. The event caused localized drainage and flooding problems in the City of Brookfield and the Village of Elm Grove, but its severest impacts occurred to the east, in Milwaukee County. The most significant impacts of the storm were experienced along the main stem of the Kinnickinnic River and along Wilson Park Creek, located in the Kinnickinnic River watershed.

DESCRIPTION OF RECENT FLOOD EVENTS

As also noted in Chapter I of this report, major flooding occurred within the City of Brookfield and the watershed areas that lie partly within its boundaries in 1997 and 1998. These flood events, both of which are highly significant with regard to the current flood mitigation planning effort for the City, include the following:

- The event of June 20-21, 1997, when a period of moderate rainfall followed by intense thunderstorms centered in northern Milwaukee County resulted in at least six inches of rain in a 26-hour period within a 13-mile-wide, 18-mile-long band which also included the extreme southern portion of Ozaukee County, southeastern Washington County, and northeastern Waukesha County. Flooding occurred throughout the communities located within this band. Locations that experienced severe, direct overland flooding included areas along Underwood Creek in the City of Brookfield and the Village of Elm Grove. In addition, there were numerous occurrences of flooding of streets and buildings, primarily in basements, in the City and the Village. Numerous instances of stormwater drainage and sanitary sewer backup problems also occurred in communities located throughout

the areas of heavy rainfall. Over the Underwood Creek and Dousman Ditch subwatersheds, the maximum 26-hour rainfall during this event ranged from about five to six inches. The recorded rainfall total at the rain gage operated by the Milwaukee Metropolitan Sewerage District (MMSD) at the Elm Grove Village Hall was 5.97 inches in 26 hours. That rainfall total has a recurrence interval of about 170 years, while the most intense period of rainfall recorded at the Village Hall, 5.01 inches in eight hours, has a recurrence interval of over 300 years. It is estimated that the flood on Underwood Creek within the City of Brookfield and the Village of Elm Grove had a recurrence interval of less than 100 years.

Flood damages during the June 1997 event were estimated to be $6.5 million in Waukesha County, including the City of Brookfield, and nearly $90 million in the greater Milwaukee area. Flood damages in the City of Brookfield were significant, but not as severe as in surrounding areas. Assistance received through the FEMA and State Hazard Mitigation and Public Assistance programs administered by the Wisconsin Department of Military Affairs, Division of Emergency Management, associated with this 1997 event totaled about $133,000 under the FEMA Hazard Mitigation program and $88,000 under the FEMA Public Assistance program. Structure-specific information based upon claims filed under the national flood insurance program for six properties totaled about $77,000, or about $13,000 per property. More-detailed data on damages to structures located within the flood hazard area is provided in Chapter IV. That chapter also describes the actions which have been taken related to structure removal from the flood hazard areas since the 1997 event.

- The event of July 2, 1997, a "follow-up" storm to the June 20-21, 1997, storm event, involved two to three inches of rain, but resulted in little additional property damage.

- The event of August 6, 1998, in which five or more inches of rain fell in northern Milwaukee County and northeastern Waukesha County, resulted in severe stormwater drainage and flooding problems. Moderate rainfalls occurred on August 4 and 5, with daily totals of generally about one inch or less. The most intense rainfall on August 6 covered a five-mile-wide, 16-mile-long band, with the heaviest rainfalls occurring within about a seven- to 10-hour period. Over the Underwood Creek and Dousman Ditch subwatersheds, the maximum seven-hour rainfall measured ranged from about 8.28 inches at the MMSD rain gage at the Elm Grove Village Hall to about 11.8 inches near the intersection of N. Calhoun Road and North Avenue in the City of Brookfield. The greatest reported 24-hour rainfall was 11.75 inches in the City of Brookfield. Flooding occurred throughout the communities located within the band of the most intense rainfall. Locations that experienced severe, direct overland flooding in a second consecutive year included areas along Underwood Creek in the City of Brookfield and the Village of Elm Grove. It is estimated that about 550 residences in the City and as many as one-half of the properties in the Village suffered damages from the overflow of streams, stormwater runoff, or sanitary sewer backup. The estimated recurrence interval for the August 1998 flood on Underwood Creek within the City and the Village is close to 500 years.

Flood damages during this August 1998 event were substantial in the City of Brookfield. Assistance received through the FEMA and State Hazard Mitigation and Public Assistance programs administered by the Wisconsin Department of Military Affairs Division of Emergency Management associated with this 1998 event totaled about $144,000 under the FEMA Hazard Mitigation program and about $318,000 under the FEMA Public Assistance program. Structure-specific information based upon claims filed under the national flood insurance program for 14 properties totaled

about $288,000, or about $21,000 per property. It was also estimated that as many as 1,500 structures experienced basement flooding due to clearwater inflow or sanitary sewer backup. Using assumptions regarding the estimated damages related to basement flooding of structures, it is estimated that the damages in the 1998 flood event would be from $4,000,000 to $5,300,000.[3] Additional detailed data on damages to structures located within the flood hazard area is provided in Chapter IV. That chapter also describes the actions which have been taken related to structure removal from the flood hazard areas since the 1998 event.

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[3]*Damage estimates are generalized and not based upon detailed site-specific surveys. It was assumed that damages to the structure and contents would be from $2,500 to $3,500 on average for the structures with reported basement flooding conditions. Actual damages may be significantly more or less for an individual structure.*

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Chapter III

FLOOD MITIGATION GOALS AND OBJECTIVES

Planning may be defined as a rational process for formulating and meeting goals and objectives. Consequently, the formulation of goals and objectives is an essential task that must be undertaken before plans can be prepared. This chapter sets forth flood mitigation goals and objectives for use in the design and evaluation of alternative flood mitigation plans for the City of Brookfield and the two watersheds that each lie partly within its boundaries, and in the selection of a recommended plan from among those alternatives.

In formulating and setting forth goals and objectives, their differing natures and purposes must be kept in mind. Goals are general guidelines that explain what a community desires to achieve. Based upon the selected goals, a community can then develop the specific objectives needed to attain the goals. Objectives define strategies for meeting the selected goals and are more specific than goals.

In the selection of goals and objectives and their application to the preparation, testing, and evaluation of plan alternatives, several basic considerations must be recognized. First, it must be recognized that any proposals for flood mitigation must constitute integral parts of a total system. It is not possible from an application of the goals and objectives alone to assure such system integration, since the goals and objectives cannot be used to determine the effect of any given individual proposed facility or other proposal on the system as a whole, nor on the environment within which the system must operate. Such determination requires the use of quantitative planning and engineering techniques developed for those purposes. Second, it must be recognized that it is unlikely that any one plan proposal will fully meet all applicable goals and objectives; the extent to which each applicable goal and/or objective is met, exceeded, or violated must serve as the measure of the ability of each alternative plan proposal to achieve the applicable goal(s) and/or objective(s). Third, it must be recognized that there may be cases where certain goals and/or objectives may conflict, and that such conflicts may require resolution through compromise, such compromise being an essential aspect of any planning or design effort. Finally, it should be recognized that goals and objectives may, in some cases, be specific to a particular watershed or subwatershed area. Accordingly, certain citywide goals and objectives may be refined as detailed floodland and stormwater management plans are prepared for each specific subarea of the City and its related watershed(s) or subwatershed(s).

RELATIONSHIP OF FLOOD MITIGATION GOALS AND OBJECTIVES TO COMMUNITY DEVELOPMENT AND PARK AND OPEN SPACE OBJECTIVES

As described in Chapter II, the City of Brookfield has prepared and adopted a park and open space plan[1] to guide the City in preserving and developing recreational and other open space uses throughout the City. That plan is currently being updated. In addition, similar plans have been prepared by Milwaukee and Waukesha Counties and by many of the communities in the two watershed areas involved. As park and open space planning and floodland management planning are carried out in the City of Brookfield and in the related watersheds, an integration and coordination of the goals and objectives has taken place. In addition, land use planning goals and objectives are integrated and coordinated with floodland management planning. This is accomplished at the watershed level by developing comprehensive watershed plans which include floodland management, land use, park and open space, and water quality planning in one integrated planning program. These watershed plans form a potential framework for subwatershed-level planning programs. As an example, the comprehensive watershed planning objectives, principles,

[1] *SEWRPC Community Assistance Planning Report No. 108,* A Park and Open Space Plan for the City of Brookfield, Waukesha County, Wisconsin, *August 1991.*

and standards for the comprehensive plan for the Menomonee River watershed[2] include six specific objectives and supporting standards related to land use and park and open space use, as well as objectives and standards relating to flood control. A copy of the objectives, principles, and standards used for development of the comprehensive plan for the Menomonee River watershed is included in Appendix C of this report. Similarly, the City of Brookfield park and open space plan contains a specific plan elements for wetland and floodland preservation. A copy of these plan elements is included in Appendix A of this report.

FLOOD MITIGATION GOAL AND OBJECTIVES FOR THE CITY OF BROOKFIELD

In response to the significant flooding experienced in the City of Brookfield in 1997 and 1998, the Mayor and the Common Council of the City authorized the creation of a Citywide Flood Task Force to research problems, identify needs, and present policy recommendations that would provide direction to present and future stormwater planning initiatives for the City.

The City Common Council also responded to concerns arising from the 1997 and 1998 flooding in the City by approving the establishment of a separate Underwood Creek Task Force. The Underwood Creek Task Force was designed to be a cooperative effort between the City of Brookfield and the Village of Elm Grove.

The Citywide Flood Task Force received extensive technical support from the City and the Southeastern Wisconsin Regional Planning Commission (SEWRPC) staffs throughout the process of developing initial recommendations. The Task Force also used the City of Brookfield's October 1995 stormwater management guide as a resource. As an important first step in its efforts, the Task Force sought to establish a common understanding of the relationship between flood control planning and stormwater management planning.

In recognition of the close interrelationships between stormwater management and flood mitigation problems and planning, the two independent Task Forces were given a common mission, or goal, to "[d]evelop recommendations for the City of Brookfield to improve stormwater management and sanitary sewer performance and to mitigate the effects of flooding throughout the City." The Citywide Flood Task Force accordingly has developed recommendations through an orderly process beginning with problem identification and extensive education relating to stormwater and sanitary sewer systems, floodplain regulations, and the relationship of wetlands to stormwater management.

In accord with its stated goal, the Task Force has made a series of recommendations designed to help accomplish the following objectives:

- The establishment of practical, cost-effective design standards for newly constructed and reconstructed stormwater conveyance systems, both major and minor.

- The review by the City, on a regional basis, of stormwater management plans for developments to realize the best planning possible in order to reduce potential or existing flooding problems, address inadequate drainage, and reduce nonpoint source pollution. This objective envisions the development of a citywide stormwater management plan and the establishment of ordinances supporting that plan.

- The elimination of natural and human-created obstructions in drainageways and easements that prevent the natural flow of water in natural and built drainageways, both public and private.

- The elimination of improper filling and grading, which can 1) create problems with setting dwelling grades, particularly in established areas, and 2) disrupt established drainage patterns.

- Toward mitigating the possibility of water supply contamination as a result of floodwaters 1) contaminating private wells and/or

[2] *SEWRPC Planning Report No. 26,* A Comprehensive Plan for the Menomonee River Watershed, *Volume One,* Inventory Findings and Forecasts, *October 1976, and Volume Two,* Alternative Plans and Recommended Plan, *October 1976.*

2) bypassing the sewer system and/or causing sewer backups in homes, the abandonment, wherever municipal water supply is available, of private wells; the exploration of possible extension of municipal water supply service to homes in the floodplain or in areas subject to sewer capacity problems; and the bringing of all wells into compliance with current applicable Wisconsin Department of Natural Resources (WDNR) regulations.

- The abatement or mitigation of flooding problems, including sewer backups occurring outside the floodplain when floodwaters enter the sewer system through flooded homes, arising due to the location of structures and fill within the floodplain. The Task Force has recommended a series of specific means for accomplishing this objective, including the active enforcement of floodplain zoning ordinances, consideration of developing and adopting floodplain maps and flood profiles for streams for which no flood hazards are currently delineated, the establishment of policies with regard to structures located in the floodplain, and, where appropriate, the examination of other means of alleviating flooding, such as detention storage and modification of stream channels and/or bridges.

- The consideration by the City of the possible purchase of private property when such purchase is cost-effective in solving areawide problems when viewed in conjunction with other possible solutions. In certain cases, the most effective solution to an areawide flooding or stormwater problem may be the removal of buildings or the use of private lands to either 1) build stormwater facilities or 2) eliminate a threat to other properties caused by the location of a building. In reviewing cost-effectiveness, however, the private cost of loss of personal possessions and cleanup of damage should be considered.

- The evaluation by the City, in accord with policies established by either the Task Force or the City Common Council, of current and future studies that address various stormwater concerns of the City. Current and new studies should be reviewed for appropriate action, assignment of priorities, and funding to accomplish the City's stormwater program. This review process should include 1) follow-up to assure that problem areas are being addressed appropriately and 2) reevaluation of existing studies when situations change. It is important to develop a tracking and archiving system for all such studies.

- The pursuit, given the lack of funding by the State of Wisconsin for the extensive costs entailed by a comprehensive stormwater program, of various means of financing stormwater improvements, taking into account how stormwater concerns extend beyond municipal boundaries and must be addressed on a cooperative, areawide basis.

In addition to the above objectives, the Citywide Flood Task Force has set forth a series of related objectives pertaining to mitigating or abating sanitary sewer backup problems relating to flooding.

CITY OF BROOKFIELD YEAR 2020 MASTER PLAN

Building upon other City and watershed planning programs, the City's 2020 master plan includes a specific goal and objectives related to floodland and stormwater management. The goal of that plan is, "Adopt a coordinated approach to stormwater management that addresses the flooding issues on a regional or sub area basis." In support of that goal, the master plan includes the following three objectives:

- Prohibit further construction and alterations to the floodplain. Consider mandatory setbacks from the floodplain.

- Integrate selected stormwater solutions with new opportunities for park and recreational development.

- Explore creative measures for financing stormwater mitigation, such as implementation of a stormwater utility.

The master plan references parallel ongoing programs as the means to achieve the identified goals and objectives. All of these programs are specifically incorporated into this flood mitigation plan.

RELEVANT GOALS AND OBJECTIVES OF OTHER PLANNING EFFORTS

The above goal and objectives, as well as the current flood mitigation planning effort for the City of Brookfield, must be treated in the context of historical and current related planning efforts undertaken for the area by SEWRPC, the Milwaukee Metropolitan Sewerage District (MMSD), and private consultants. Each of the plans involved sets forth a series of goals that are relevant to the current flood mitigation planning effort for the City.

Stormwater Management Guide for the City of Brookfield

As noted above, the Citywide Flood Task Force used the City of Brookfield's October 1995 stormwater management guide as a resource. This guide, prepared for the City by Rust Environment & Infrastructure (now known as Earth Tech, Inc.) and with partial financial assistance from the WDNR, sets forth nine goals with supporting objectives to give direction to the City's stormwater management program. These nine goals may be summarized as follows: 1) the addressing of Federal, State, and local regulatory requirements; 2) the protection of life, property, and the environment from stormwater damage; 3) the protection of the groundwater supply; 4) the maintenance and enhancement of diversity of the natural environment; 5) the enhancement of recreational and aesthetic features of the City; 6) support partnerships between the City and private developers in stormwater management efforts; 7) the establishment of an equitable and reliable means of financing applicable operation and maintenance, and construction projects; 8) the resolution of floodplain delineation and regulatory issues; and 9) provision of leadership in Southeastern Wisconsin and the State of Wisconsin.

SEWRPC Watershed Plans

As part of its continuing planning program for the seven-county Southeastern Wisconsin Region, SEWRPC has prepared and adopted comprehensive plans for the two watersheds that lie partly within the City of Brookfield. The two plans each set forth a series of detailed water control facility development objectives, as well as related land use and park and open space objectives. In both plans, the Commission defines an "objective" as "a goal or end toward the attainment of which plans and policies are directed." Each objective, or goal, is 1) supported by a stated fundamental, primary, or generally accepted planning principle that supports the objective and asserts its inherent validity and 2) accompanied by a set of quantifiable planning standards that can be used to evaluate the relative or absolute ability of alternative plan designs to meet the stated development objective. The principles and standards serve to facilitate quantitative application of the objectives during plan design, testing, and evaluation.

An objective common to both watershed plans envisions "[a]n integrated system of drainage and flood control facilities and floodland management programs which will effectively reduce flood damage under the existing land use pattern of the watershed and promote the implementation of the watershed land use plan, meeting the anticipated runoff loadings generated by the existing and proposed land uses" within each watershed. An example of the comprehensive watershed planning objectives and supporting principles and standards is included in Appendix C.

Stormwater and Floodland Management Plan for the Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove

In cooperation with the City of Brookfield, the Village of Elm Grove, and the WDNR, SEWRPC and the private engineering and land surveying firm Ruekert & Mielke, Inc., are currently in the process of preparing a stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds in the City and the Village. As in the case of SEWRPC's watershed plans, this plan sets forth a series of objectives, or goals, to guide the design, testing, and evaluation of alternative plans and the selection of a recommended plan from among the alternatives considered. Each of the seven stormwater and floodland management goals of the subwatershed-level plans is accompanied by a set of supporting standards. The goals are as follows:

- The development of a stormwater and floodland management system which reduces the exposure of people to drainage-related inconvenience and to health and safety hazards and which reduces the exposure of real and personal property to damage through inundation resulting from flooding and inadequate stormwater drainage.

- The development of a system which will effectively serve existing and planned future land uses and will promote implementation of

the adopted land use plan set forth in the Waukesha County development plan.

- The development of a stormwater management system which will abate nonpoint source water pollution and help achieve the recommended water use objectives and supporting water quality standards for surface-waterbodies.

- The development of a system which will maintain or enhance existing terrestrial and aquatic biological communities, including fish and wildlife.

- The development of a stormwater and floodland management system which will be flexible and readily adaptable to changing needs.

- The development of a stormwater management system which will not pollute the groundwater aquifers serving the City and the Village.

- The development of a stormwater and floodland management system which will efficiently and effectively meet all of the above six goals at the lowest practicable cost.

Plans Prepared for MMSD

In 1990, SEWRPC prepared a comprehensive stormwater drainage and flood control system plan for the MMSD. In preparing this plan, SEWRPC formulated and used a series of objectives, principles, and standards similar to those used in preparing its watershed plans. In the system plan prepared for the MMSD, the following water control facility development objectives, or goals, were set forth: 1) the development of an integrated system of drainage and flood control facilities and floodland management programs which will effectively reduce flood damage under the existing land use pattern within the District boundaries and promote the implementation of the adopted land use plans for the watersheds in the District, meeting the anticipated runoff loadings generated by the existing and proposed land uses, and 2) the development of an integrated system of flood control and stormwater management facilities designed to minimize the negative impacts on fish and other aquatic life and to support the water use objectives set forth in the regional water quality management plan.

The proposed 1990 system plan for the MMSD reflected recommendations set forth in a 1986 stormwater drainage and flood control policy plan identifying the streams and other watercourses for which it was recommended that the District assume responsibility for flood control. The policy plan also prepared for the MMSD by SEWRPC, was adopted by the District, by Milwaukee County, and by the Cities of Franklin, Greenfield, Milwaukee, Oak Creek, Wauwatosa, and West Allis and the Villages of Brown Deer, River Hills, and Shorewood. The City of Brookfield has conditionally adopted the 1986 policy plan, which was also adopted conditionally by the Cities of Mequon, Muskego, and New Berlin and the Villages of Butler, Elm Grove, Menomonee Falls, and Thiensville. The 1990 system plan prepared by SEWRPC served as a major basis for the District's own 1990 watercourse system plan.

Current Plan Update Effort by MMSD

As noted in Chapter I of this report, the MMSD is currently engaged in its own flood management system planning efforts. The MMSD's current planning efforts, which are intended to update the District's 1990 watercourse system plan, include planning for the Menomonee River watershed and are thus relevant to the current flood mitigation planning effort for the City of Brookfield. The MMSD states its objective with regard to its current planning effort as follows: "The objective of the System Plan Update is to develop cost-effective, feasible, and implementable flood control management alternatives that minimize structure damages for major flooding events." The MMSD's current planning efforts include efforts to integrate its planning work with other planning efforts for the Menomonee River watershed and other watersheds located partly or wholly within the area of the MMSD's jurisdiction.

Stormwater Management Plan for the West Side of the Lower Menomonee River Subwatershed

An April 1995 stormwater management plan prepared by Woodward-Clyde Consultants (now known as URS Greiner Woodward Clyde) for a 2,275-acre subwatershed of the Menomonee River that includes portions of the Cities of Brookfield and Wauwatosa and of the Village of Butler, sets forth five principal goals, including goals relevant to park and open space and economic development planning, as follows: 1) helping to provide water quality suitable to support warmwater sport-fish communities and partial-body-

contact recreational activities in the Menomonee River; 2) the provision of stormwater drainage and flood control facilities to reduce drainage-related delays and inconvenience, flood damage to property, health and safety hazards, erosion and sedimentation, and debris accumulation; 3) the development of a stormwater management system that effectively serves both existing and anticipated future land uses; 4) the evaluation of the effect of stormwater management plan on water quality conditions; and 5) the provision of effective stormwater management at the lowest practicable cost.

Chapter IV

ANALYSIS OF FLOOD PROBLEMS

In order to evaluate various potential flood mitigation alternatives for the City of Brookfield and select the most effective and feasible flood mitigation strategies, the existing flooding problems in the City must first be analyzed. Accordingly, this chapter summarizes the extent and severity of the flooding problems within the City of Brookfield and the potential for those problems to increase in the future, and sets forth recent analyses of such problems as developed under detailed floodland and stormwater management plans which have been prepared for the City.

CITY OF BROOKFIELD FLOODING PROBLEM AND ONGOING FLOOD MITIGATION ACTIONS

The floodplain areas, as well as the subwatershed boundaries, within the City of Brookfield are shown on Map 7. These areas are generally located along the major stream system throughout the City. The floodplains have been delineated for a total of about 25 miles of stream within the City. The source of the hydrologic and hydraulic data for each stream reach is shown on Map 8. All of the floodplain areas for which detailed studies are available have been mapped on large-scale topographic mapping prepared at a scale of one inch equals 200 feet with a contour interval of two feet. Flood flows and stages are currently readily available for about 22 miles of the total stream reaches involved, while the floodplain for 2.6 miles of stream is delineated by approximate methods under the Federal Flood Insurance Study for the City. As noted in Chapter II of this report, the City of Brookfield has contracted with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) to update and extend the detailed hydraulic analyses covering all of the floodplain areas in the City. This work will include the addition of analyses for a 1.3-mile reach of an unstudied unnamed tributary to the Fox River and for 2.6 miles of stream for which approximate floodplain boundaries were developed. Under a cooperative program administered by Waukesha County, updated digital large-scale topographic maps for the entire City were prepared in 1998. The results of the updated and extended hydraulic analyses will be used to delineate the floodway and floodplain boundaries on the new topographic mapping. This work is expected to be completed by early in 2002. Thus, a complete up-to-date set of floodplain mapping and supporting analyses will then be in place for all of the major stream systems in the City. As that mapping is completed and as flood abatement projects occur, changes in the floodprone structure inventory are expected. This flood mitigation plan will be amended periodically, as needed, to reflect such changes.

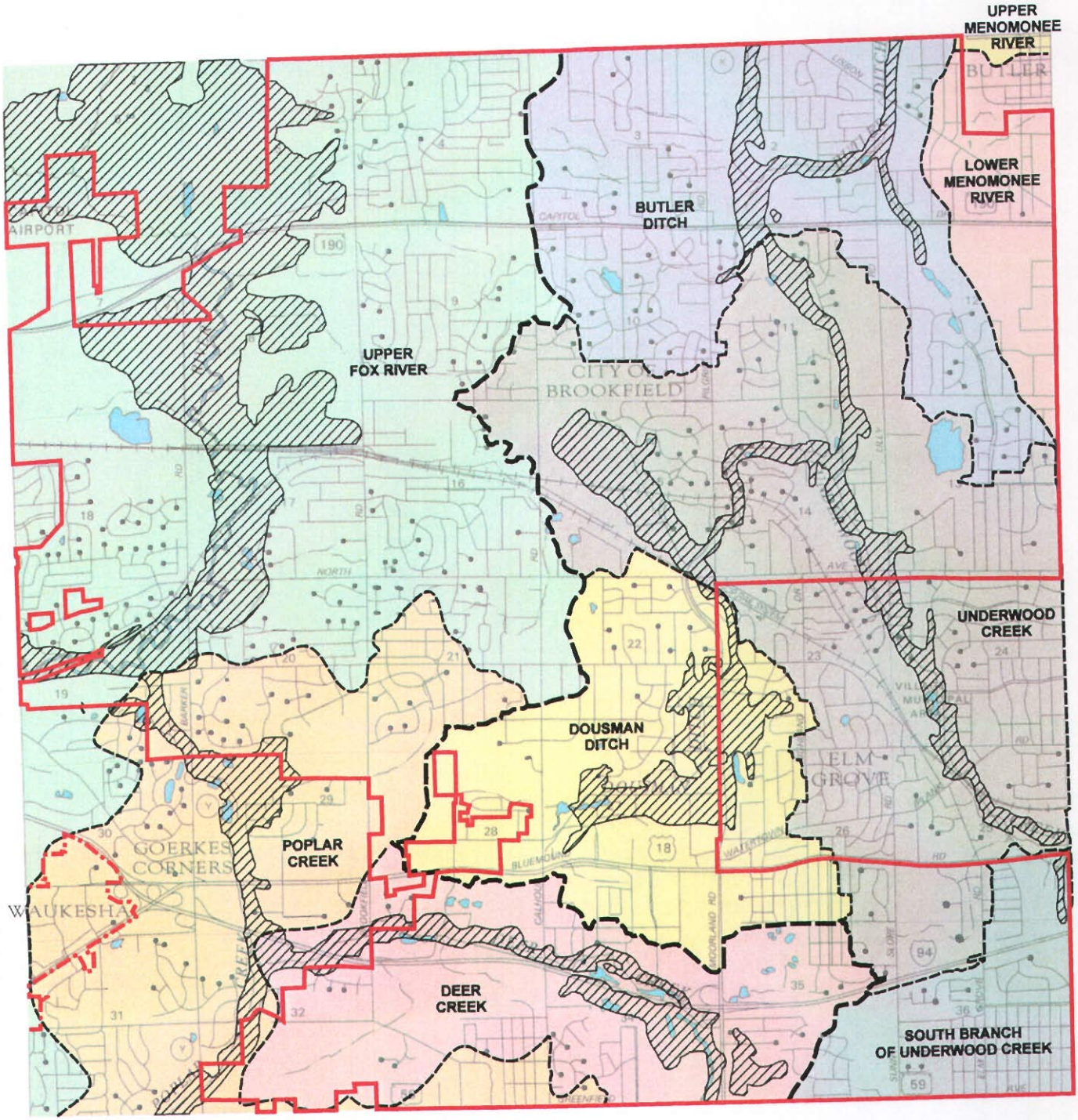
There are currently 27 structures located within the 100-year recurrence interval flood hazard areas of the City of Brookfield. These structures are shown on Map 9. As can be seen by review of this map, there are 22 residential, four business and commercial, and one other structure involved. The location of the six structures which are considered by FEMA to be repetitive- or substantial-loss properties are also shown on Map 9. Repetitive-loss structures are those which have two or more flood insurance claims of at least $1,000 each.

Detailed flood hazard data are available for each of the flood hazard areas identified. Appendix D contains selected information on each floodprone structure, including the type of structure, depth of flooding, and assessed and market values. Estimated flood damages are also included. As can be seen by review of Appendix D, the total value of the 27 structures which are identified as being subject to flooding or stormwater drainage problems is about $16 million. Damages expected during a 100-year flood event are estimated to be $820,000 and annual average damages are estimated to be $59,000.

With regard to the floodprone structures identified on Map 9 and listed in Appendix D, the City of Brookfield, in cooperation with FEMA and the Wisconsin Department of Military Affairs, Division of Emergency Management, has purchased and removed two structures from the floodplain, including structure number 10R, as shown on Map 9, which is classified

Map 7

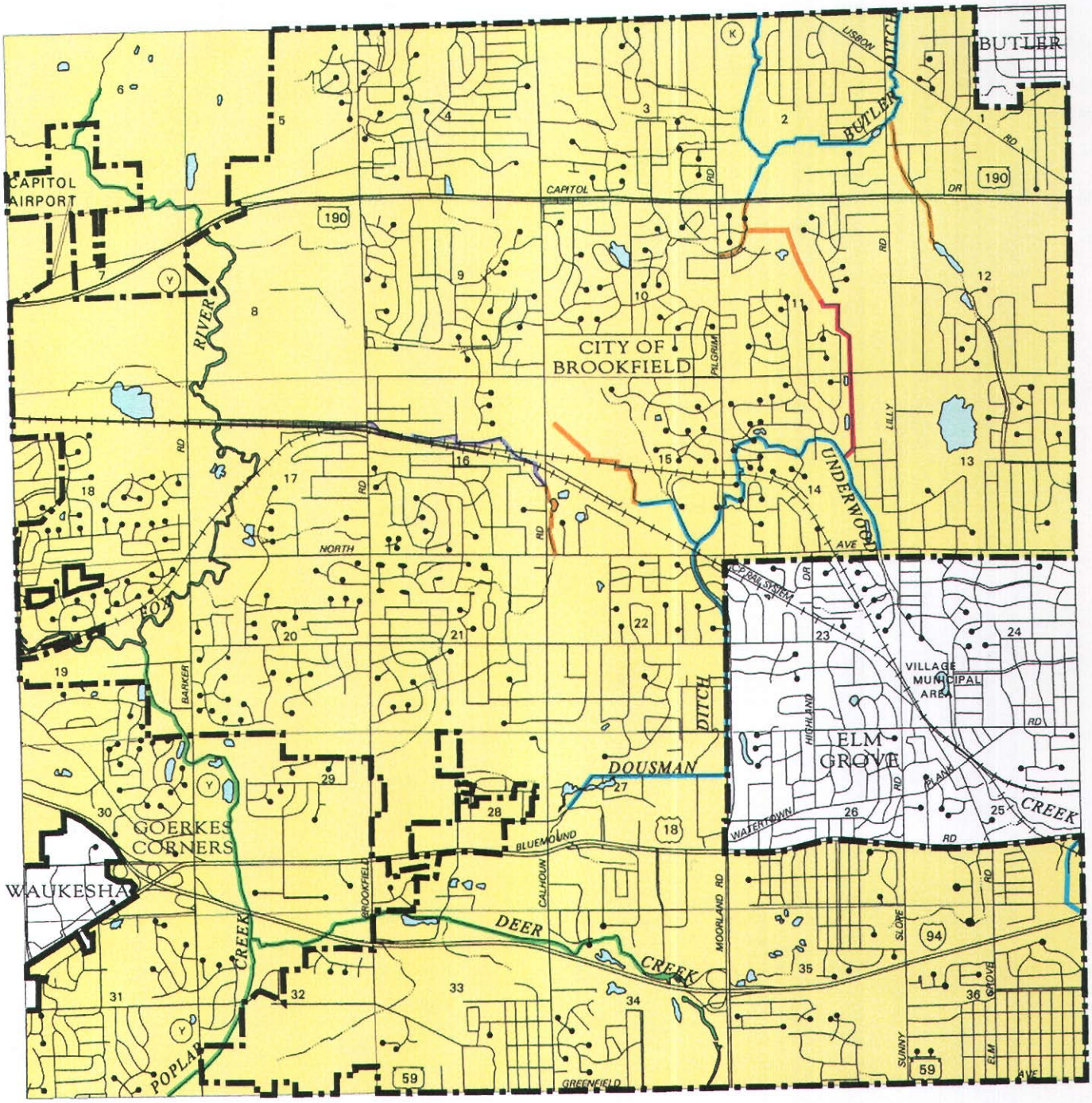
MAPPED FLOODPLAINS IN THE CITY OF BROOKFIELD AND ENVIRONS



Source: SEWRPC.

Map 8

SOURCES OF FLOOD HAZARD DATA FOR STEAM REACHES IN THE CITY OF BROOKFIELD: 2000



STUDY AREA

SOURCE OF FLOOD HAZARD DATA

STREAM REACHES FOR WHICH FLOOD FLOWS AND STAGES WERE DEVELOPED UNDER THE FOX RIVER WATERSHED STUDY AND UPDATED UNDER THE FEDERAL FLOOD INSURANCE STUDY. (FIS)-12.9 MILES

STREAM REACHES FOR WHICH FLOOD FLOWS AND STAGES WERE DEVELOPED UNDER THE MENOMONEE RIVER WATERSHED STUDY AND UPDATED UNDER THE STORMWATER DRAINAGE AND FLOOD CONTROL SYSTEM PLAN FOR MILWAUKEE METROPOLITAN SEWERAGE DISTRICT.-8.2 MILES

STREAM REACHES FOR WHICH FLOWS AND STAGES WERE DEVELOPED UNDER THE (FIS).-1.0 MILES

APPROXIMATE DELINEATIONS UNDER THE (FIS) WHICH ARE PROPOSED TO BE DETAILED DELINEATIONS IN YEAR 2000 UNDER CITY OF BROOKFIELD STUDY-2.6 MILES

REACHES NOT DELINEATED UNDER THE (FIS) WHICH HAVE SUBSEQUENTLY BEEN DETAILED UNDER A CITY OF BROOKFIELD STUDY-1.3 MILES

GRAPHIC SCALE

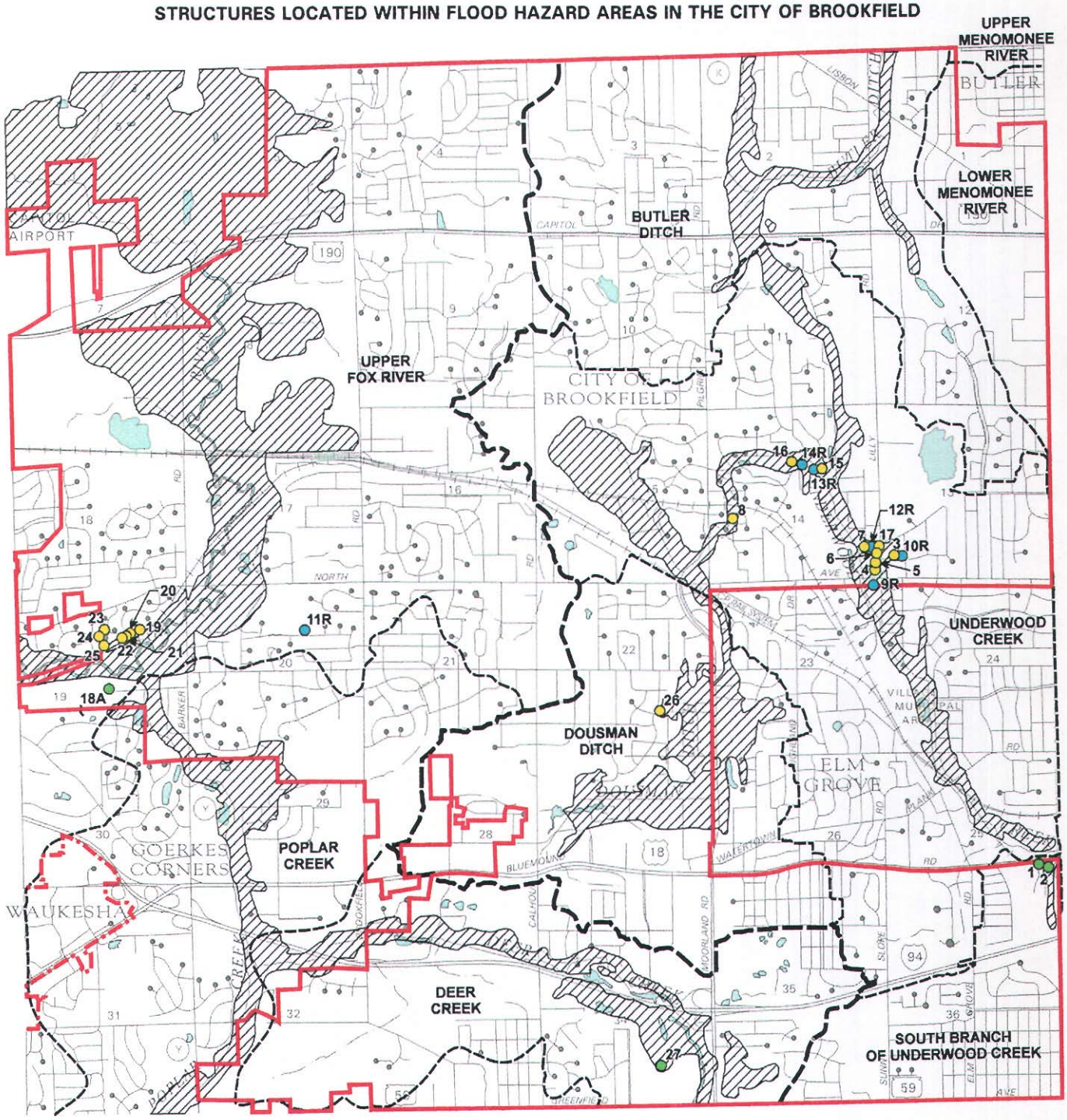
0 1/2 1 MILES

0 2000 4000 6000 FEET

Source: SEWRPC.

Map 9

STRUCTURES LOCATED WITHIN FLOOD HAZARD AREAS IN THE CITY OF BROOKFIELD



- SUBCONTINENTAL DIVIDE
- SUBWATERSHED BOUNDARY
- CITY OF BROOKFIELD CORPORATE LIMIT
- CITY OF WAUKESHA CORPORATE LIMIT
- FLOODPLAIN (100 YEAR RECURRENCE INTERVAL)
- RESIDENTIAL STRUCTURE
- BUSINESS OR COMMERCIAL STRUCTURE
- REPETITIVE LOSS STRUCTURE
- 7 STRUCTURE ID NUMBER (SEE APPENDIX D)

GRAPHIC SCALE
0 1/2 1 MILES
0 2000 4000 6000 FEET

Source: City of Brookfield, FEMA, and SEWRPC.

as a repetitive-loss structure. The second structure removed was not included on Map 9, as it was removed prior to the floodprone structure inventory prepared for this report. In addition, the City is working with FEMA and the State Division of Emergency Management to secure funding for the purchase and removal of structures 4, 5, 6, 7, 12R, and 17, as shown on Map 9. These implementation actions are consistent with the recommendation of the detailed flood mitigation planning carried out within the City as described in Chapters V and VII.

It should be noted that, with the exception of the repetitive loss structures, all of these structures were identified as being in the floodplain based upon the best available topographic mapping. Field surveys would be required to determine the precise relationship to the floodplain. In addition, there are also a number of buildings located adjacent to, or are located on islands within, the floodplain, based upon the topographic mapping. Information regarding those structures is on file with the City of Brookfield Department of Community Development. As part of the flood mitigation plan implementation, field survey data will be obtained for all floodprone structures.

In addition to the structures which lie within the floodplain, there are other areas within the City which experience flooding and stormwater drainage problems. These areas have been identified in the City's October 1995 Stormwater Management Guide. A map of the 48 areas identified as experiencing flooding and related problems and a general description of the problem are included in Appendix E. The problems generally included frequent street flooding and backup of stormwater at culverts and other structures causing yard and parking area flooding.

As described in Chapter II of this report, two recent flood events occurring on June 20-21, 1997, and August 6, 1998, resulted in unusual problems within the City due to a combination of extremely high flood flows, power outages and associated sump pump failures, and sanitary sewer capacity problems. A description of these two events is included in Chapter II of this report.

The event of June 20-21, 1997, when a 26-hour storm involving a period of moderate rainfall followed by intense thunderstorms centered in northern Milwaukee County resulted in about six inches of rain in a 13-mile band which included portions of the City of Brookfield. The June 21, 1997, flood recurrence interval determined for the peak flood flows in the City of Brookfield on Underwood Creek was less than 100 years, while the recurrence interval of the flood downstream of the City in the Village of Elm Grove exceeded 100 years. Estimated damages due to this flood were estimated to be nearly $90 million in the greater Milwaukee area, of which about $6.5 million were estimated for Waukesha County, including the City of Brookfield. A Presidential Disaster Declaration was made due to flooding in this event. Assistance received through the FEMA and State Hazard Mitigation and Public Assistance programs administered by the Wisconsin Department of Military Affairs, Division of Emergency Management, associated with this 1997 event supported City of Brookfield flood mitigation projects with total costs of $133,000 under the FEMA Hazard Mitigation program and $88,000 under the FEMA Public Assistance program.

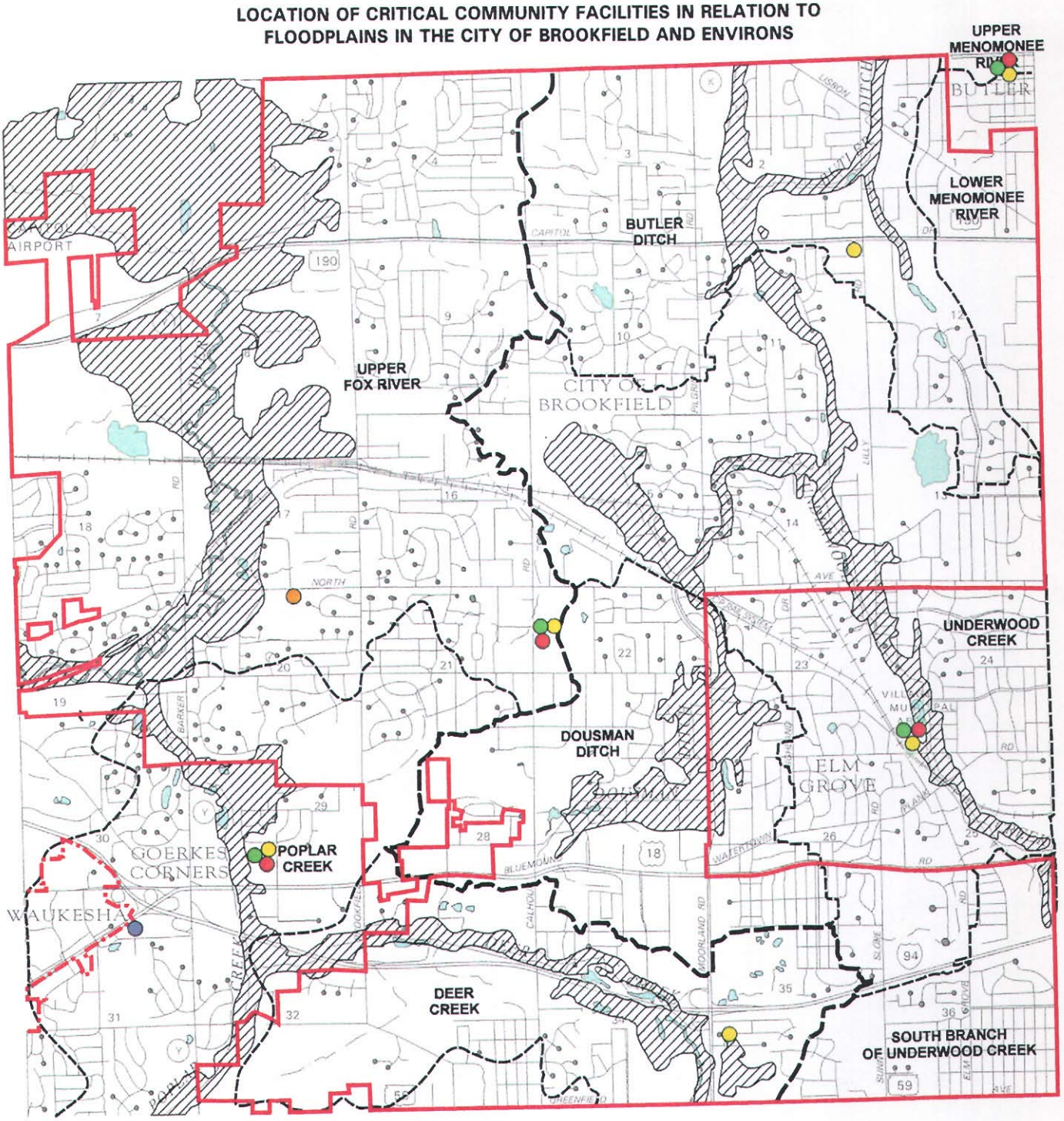
The event of August 6, 1998, in which over five inches of rain in portions of the City of Brookfield resulted in severe stormwater drainage and flooding problems. Estimated flood damages during this 1998 event were estimated to exceed $4.0 million in the City of Brookfield. A Presidential Disaster Declaration was made due to flooding in this event. Assistance received through the FEMA and State Hazard Mitigation and Public Assistance programs administered by the Wisconsin Department of Military Affairs Division of Emergency Management associated with this 1998 event supported flood mitigation projects with total costs of $144,000 under the FEMA Hazard Mitigation program and $318,000 under the FEMA Public Assistance program.

CITY OF BROOKFIELD FLOODING-RELATED COMMUNITY IMPACTS DESCRIPTION

Map 10 shows the location of selected types of critical community facilities including fire and police stations, hospitals, and community administration facilities within the City and adjacent areas. None of these facilities are located within the flood hazard areas. However, because of the need for access to and from these facilities, the flood mitigation plan includes their location and shows the relationship to the flood hazard areas. There are no schools, nursing homes, or other critical facilities located within the flood hazard areas within the City.

Map 10

LOCATION OF CRITICAL COMMUNITY FACILITIES IN RELATION TO FLOODPLAINS IN THE CITY OF BROOKFIELD AND ENVIRONS



Source: SEWRPC.

A review of the extent and severity of flooding conditions within the City of Brookfield indicates that there is a significant community impact primarily as a result of the damages caused by flooding of buildings, primarily basements, and disruption of the transportation system during extreme flooding events. Most importantly, the contribution of overland flooding to the problem of basement sanitary sewer backup is a major community concern related to public health and safety. As an example, flooding of streets and buildings, primarily basements, was reported in the City as a result of the June 20-21, 1997, storm. Several types of structure flooding occurred. One major source of basement flooding problems was surcharging of sanitary sewers and resultant backups into basements. Another source of basement flooding was sump pump failure due to electrical power outages. Those two problems are interrelated. If sump pumps cannot operate and the volume of clearwater collected by a building's foundation drain system exceeds the capacity of the sump crock, water will overflow from the crock into the basement. That clearwater then flows into the basement floor drain, which is connected to the sanitary sewer. Excessive flows of such clearwater into the sanitary sewers can quickly exceed the capacity of those relatively small-diameter sewers, leading to surcharging and backup of a combination of sanitary sewage and clearwater into basements connected to the surcharged sewers. Additional sources of clearwater inflow to sanitary sewers were through: 1) flooding of basements due to surface runoff, 2) excessive amounts of water collecting in streets or roadside swales and entering sanitary sewer manholes through unsealed lids and frames, 3) sanitary sewer manhole lids which were disturbed, and 4) missing caps on sanitary sewer lateral cleanouts located in roadside swales.

The flooding impacts on the community infrastructure and the need to prepare for major evacuations and other emergency actions are not a significant concern given the isolated nature and the severity of the overland flooding problems. However, the coordinated Waukesha County and City of Brookfield Emergency Operations Planning Program do have provisions for carrying out the latter if it would be needed. Furthermore, significant flood-related impacts on the community economy and businesses are of an infrequent and short-term nature. The only impacts on City operations which are relatively frequent involve posting and closure of a few roadway locations where floodwaters frequently overtop structures and cause short-term roadway flooding.

POTENTIAL FUTURE CHANGES IN FLOODPLAIN BOUNDARIES AND PROBLEMS

As described in Chapter II of this report, the City of Brookfield currently has in place land use controls and planning programs to preserve nearly all of the remaining environmentally sensitive areas, including wetlands and floodplains, in the City. Furthermore, development within the City itself is approaching "buildout" conditions with new development expected to be largely limited to infilling and isolated open space parcels outside of the environmentally sensitive areas. The City has adopted a stormwater management ordinance to codify policies that have been implemented in the recent past. This ordinance will require sound stormwater management practices and will limit any increases in future stormwater runoff peak rates of flow. This applies to both new development and redevelopment. Accordingly, there is not expected to be any significant changes in the flood flows and hydrologic characteristics of the stream system resulting from future land use changes in the City. Detailed analyses conducted under the recently completed stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds[1] in the City of Brookfield and the Village of Elm Grove have verified that there will be no significant increases in future flood flows or stages within the Dousman Ditch and Underwood Creek subwatersheds. As shown on Map 7, both of these subwatersheds have their headwater areas located entirely within the City, and with respect to flooding, are thus not affected by development beyond the City limits.

A review of the City land use plan indicates that redevelopment activities within the City will not have a significant impact on future flood flows and stages. As noted above, such redevelopment is governed by the City stormwater management ordinance which

[1] *SEWRPC Community Assistance Planning Report No. 236,* A Stormwater and Floodland Management Plan for the Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove, Waukesha County, Wisconsin, *February 2000.*

limits impacts of future development or redevelopment on flood flows or stages.

With regard to the impact of development beyond the City of Brookfield limits, however, nearly all of the developing communities lying upstream of the City, including the City of New Berlin (Deer Creek and Poplar Creek subwatersheds), the Village of Menomonee Falls (Butler Ditch subwatershed), and the Village of Sussex and the Town of Brookfield (Upper Fox River subwatershed) have recently prepared or have under preparation detailed stormwater management plans and/or stormwater-related ordinances designed to minimize any negative downstream impacts on flood flows and stages. In addition, most of the communities in the Upper Fox River subwatershed are currently involved in the Wisconsin Department of Natural Resources (WDNR) stormwater permitting program as set forth under Chapter NR 216 of the *Wisconsin Administrative Code*. This program will eventually lead to the development of additional stormwater management practices.

In addition to the above and as described in Chapter II of this report, the City of Brookfield's current floodplain zoning regulations are designed to prevent the development of any new floodprone development, as well as to prevent any floodplain encroachment that would cause changes in the existing flood flows or stages.

Based upon the above, it can be concluded that the extent and severity of the flooding problem within the City will not become significantly more severe in the future. However, this conclusion is based upon the assumption of, and highlights the importance of, carrying out and implementing current floodplain and related ordinances and existing and ongoing stormwater management plans and regulations.

SUMMARY OF STORMWATER AND FLOODLAND MANAGEMENT PLAN FLOOD PROBLEM ANALYSES

The identification, analysis, and recommendation of possible methods of abating or mitigating recent and current flooding problems in the City have been the subject of various planning efforts undertaken by and for the City, either with regard to the City as a whole or to various portions of it. Recent analyses of flooding problems in the City include the citywide analyses performed in preparing 1) the City's 1995 stormwater management guide, prepared by Rust Environment & Infrastructure (now known as Earth Tech, Inc.) and adopted by the City on October 3, 1995, and 2) the 1999 initial report of the City's Citywide Flood Task Force. Other recent analyses, focusing only on specific portions of the City, include 1) the 124th and Congress Streets stormwater drainage problem analysis, which involved a small portion of the Menomonee River watershed in the northeastern corner of the City, and 2) the detailed analyses recently completed as part of the preparation of the aforementioned comprehensive stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds in the City and in the Village of Elm Grove. The analysis of the stormwater drainage problems in the vicinity of 124th Street and Congress Street was prepared in 1998 by the private engineering and land surveying firm Ruekert & Mielke, Inc., for the City of Brookfield. The plan for the Dousman Ditch and Underwood Creek subwatersheds in the City and Village was prepared in 1999 by the SEWRPC and Ruekert & Mielke, Inc., in cooperation with the City, the Village, and the WDNR.

1995 Stormwater Management Guide

The 1995 City stormwater management guide includes the identification of 48 discrete locations, or "problem areas," affected by flooding and stormwater problems within the City. These areas are identified on Map E-1 and in Table E-1, both in Appendix E of this report. One such area, located near N. 124th Street and W. Congress Street, was identified as significantly floodprone and was studied in more detail, as discussed further in the next section of this chapter.

The City's stormwater management guide describes many of the 48 problems areas as having operation and maintenance problems that could be addressed with City crews through a reallocation of priorities and resources. Other problems in the identified problem areas were described as 1) being either too complex or too large to be addressed by City resources, thus probably requiring the City to contract with other parties for their resolution, or 2) located outside the City's jurisdiction. The flooding and stormwater problems identified by City staff were classified into four general types: 1) frequent street flooding at scattered locations; 2) flooding caused by urban development placing excessive hydrologic loads on existing culverts and other hydraulic structures; 3) potential problems expected to develop in the near future as a result of additional urbanization; and 4) maintenance difficulties. The maintenance difficulties identified were classified into three types: 1) situations where the

City has no legal authority to enter drainageways to remove obstacles that apparently aggravate upstream flooding; 2) locations where the City has legal access, but where that access is physically blocked by fences, structures, and/or other built obstacles; 3) locations where the City has legal access, but where access is limited by large trees and other vegetation; and 4) situations where the City cannot take action because of difficulty in obtaining required permits from the WDNR and/or the U.S. Army Corps of Engineers.

124th and Congress Streets Stormwater Analysis

In 1998, Ruekert & Mielke, Inc., prepared an analysis of the stormwater drainage and associated flooding problems in the vicinity of 124th Street and Congress Street. This analysis was an update and refinement of a 1995 plan prepared by Woodward-Clyde consultants (now known as URS Greiner Woodward Clyde) for the Cities of Brookfield and Wauwatosa. The study considered a 2,275-acre portion of the Menomonee River watershed.

Flooding problems in the vicinity of 124th Street and Congress Parkway result in about 25 structures within the City of Brookfield being located within the stormwater flood hazard area identified in this study. This problem is caused by the backup of stormwater discharging from the industrial area in the vicinity of 124th Street and Congress Street as it is conveyed by culvert under a Union Pacific Railroad switching yard located east of N. Mayfair Road. The capacity of the existing box culvert under the railroad facilities cannot convey the stormwater flows without backing stormwater up in upstream drainage culverts and ditches to levels which flood about 25 structures within the City, as well as others in the City of Wauwatosa and Village of Butler. The area impacted is shown on Map F-1 in Appendix F. Map F-2 in Appendix F shows the elevations of the floodplain structures and the associated stormwater ponding elevations.

Stormwater and Floodland Management Plan for the Dousman Ditch and Underwood Creek Subwatersheds

The recently completed stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds within the City of Brookfield and the Village of Elm Grove includes detailed inventories and analyses of factors relevant to sound stormwater and floodland management planning, including existing and planned "buildout" land use conditions, hydrologic and surface-water-quality conditions, existing stormwater drainage and flood control systems, and historical and existing flooding problems, in the subwatersheds areas involved. Peak rates and critical volumes of stormwater runoff, as determined by the hydrologic and hydraulic characteristics of each subbasin in the study area, were estimated using the XP-SWMM Stormwater Management Model computer program. This modeling indicated locations where the capacities of conveyance facilities were exceeded and the locations where surface ponding, flooding, and surcharging of drainage facilities occurred.

In addition, the plan for the Dousman Ditch and Underwood Creek subwatershed areas presents information regarding the discrete general locations of existing stormwater drainage and flooding problem areas within the subwatershed areas, as identified by the City and Village based on historical observations, including the major flooding events that occurred in the City and Village in 1997 and 1998. The hydrologic and hydraulic analyses conducted as part of the planning effort verified the existence of the most significant problems identified by the City and the Village. These analyses also identified additional system components that have inadequate hydraulic capacity under existing and/or planned land use conditions. The plan includes detailed descriptions and analyses of the flooding and stormwater drainage problems within the subwatershed areas resulting from the 1997 and 1998 major storm events.

City of Brookfield Flood Task Force

As noted in Chapter III of this report, the Mayor and the Common Council of the City of Brookfield authorized the creation of the Citywide Flood Task Force after the City experienced significant flooding in 1997 and 1998 because of record rainfall. The Task Force was created to research problems, identify needs, and present policy recommendations regarding present and future stormwater planning initiatives for the City.

Data presented to the Task Force indicate that the City's existing sanitary sewers, for the most part, are properly sized given normal design considerations. However, experience has indicated a direct correlation between the amount of rain received, stormwater flooding, and sanitary sewer backup. Surface water entering only a few structures can result in extensive sanitary sewer backups located a substantial distance from the actual flooding. As the Task Force has noted, two four-inch sewer laterals feeding clearwater into

the sanitary sewer system as a result of flooded basements have the capacity to overwhelm an eight-inch sanitary sewer main running through the neighborhood involved. Although rainfall amounts cannot be controlled, actions can be taken to alleviate or mitigate the effects of precipitation once it is received. The Task Force noted that both the City and its individual residents could each participate in efforts to reduce flooding in the City.

The Task Force found that a lack of uniform citywide design standards resulted in capacity issues relative to the conveyance of stormwater in both the minor and the major conveyance systems. The Task Force also agreed that while it was not practical for the City to finance and build a stormwater system capable of handling all flooding events, it was necessary to establish design standards for newly constructed and reconstructed stormwater conveyance systems, both minor and major. The Task Force therefore recommended that such minor stormwater conveyance systems provide protection from a 10-year recurrence interval event, and that such major stormwater conveyance systems be designed to provide protection from a 100-year recurrence interval event. The 10-year and 100-year recurrence intervals respectively equate to a 10 percent and a 1 percent recurrence probability in any one year.

In its initial report, the Task Force made the following findings with regard to the 1997 and 1998 flood events:

- The natural waterways throughout the City experienced flooding. Streamflows exceeded channel capacities and floodwater moved into the floodplain. Structures located in the floodplain experienced basement and, in some cases, first-floor flooding. Public streets were overtopped and roadways were closed to traffic. Areas that experienced flooding were in the vicinity of Clearwater Drive, Lilly Road, and Pomona Road adjacent to Underwood Creek; Deer Creek and Calhoun Road; the Butler Ditch and Lilly Road; Barker Road and North Avenue; and Nassau Drive both north and south of Burleigh Road.

- Several areas of the City experienced stormwater flooding. The Coach House Village, Cardinal Crest, Indianwood, Honey Creek Estates, Imperial Estates, Parc du Chateau, Greenfield Heights, Tanglewood, Lamplighter, Royal Oak, Lynndale, and Northeast Industrial areas are examples of areas that experienced overland flooding, even though they were not located in floodplains.

- Many areas of the City experienced sanitary sewer backups. The sanitary sewer backups have a direct relationship to the location of flooding and clearwater entering the sanitary sewer system through floor drains in flooded basements.

While the areas specifically identified in the above list do not constitute an all-inclusive listing, they are a representation of areas where flooding problems occurred in the City.

Chapter V

ALTERNATIVE FLOOD MITIGATION STRATEGIES

Floodland management may be defined as the planning and implementation of a combination of measures intended to reconcile the floodwater conveyance and storage function of floodlands with the space needs and other socioeconomic needs of a resident population. Specific purposes of floodland management include elimination of loss of life, lessening of danger to human health and safety, minimization of monetary damage to private and public property, reduction in the cost of utilities and services, and minimization of disruption in community affairs. Floodland management also involves the avoidance of intensification of existing and creation of new flood hazards. A broader goal is the enhancement of the overall quality of life of residents of the area involved by protection of those environmental values—recreational, aesthetic, ecological, and cultural—normally associated with, and concentrated in, riverine areas.

The preparation of a flood mitigation plan for the City of Brookfield involves the development of alternative plan elements, a comparative evaluation of those elements, and the synthesis of the most effective elements into an integrated plan. This chapter describes the alternative flood mitigation plans considered to resolve the identified flooding problems within the City of Brookfield.

GENERAL DESCRIPTION OF POTENTIAL FLOOD MITIGATION STRATEGIES

Floodland management techniques may be broadly divided into two categories—structural measures and nonstructural measures. Structural measures include floodwater storage facilities such as reservoirs and impoundments; diversion facilities such as dikes and channels; floodwater containment facilities such as earthen dikes and concrete floodwalls; floodwater conveyance facilities, such as major channel modification; and bridge and culvert modifications or replacements. Nonstructural measures include reservation of floodlands for conservation, recreation, and other open space uses; floodland use regulations; land use controls outside the floodlands; structure floodproofing and elevation; structure removal; channel maintenance; community education programs; flood insurance; lending institution policies; real-estate-agent policies; community utility policies; and emergency programs. Structural measures tend to be more effective in achieving the objectives of floodland management in riverine areas that have already been urbanized, while nonstructural measures, being preventive, are generally more effective in riverine areas that have not yet been converted to flood-damage-prone development, even in cases where such areas have the potential for such development. However, structure floodproofing and removal have proven to be viable measures for portions of the urbanized flood hazard areas in the City of Brookfield and the Menomonee River watershed.

Table 6 lists the alternative structural and nonstructural floodland management measures that may potentially apply, individually or in combinations, to the stream network within the City of Brookfield, and summarizes the function of each. Further information regarding 1) the functions, 2) the key factors, or basic requirements used to determine if a given alternative applies to a particular riverine area or portion of a watershed, and 3) some of the more significant positive and negative features of each alternative potential flood mitigation strategy involved is set forth in the series of watershed and subwatershed plans prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and the Milwaukee Metropolitan Sewerage District (MMSD) watercourse management plan. In the evaluation of alternative measures, the comprehensive watershed planning program gives priority to those nonstructural measures, such as floodplain open space preservation and regulation, which are preventative in nature. Beyond that, each alternative to be considered must have been shown at the systems level of planning to be technically feasible and economically and environmentally sound. The determination of technical feasibility should be based upon analyses, preferably hydrologic and hydraulic simulation model studies such as those conducted for this plan. Those analyses should clearly indicate that

Table 6

ALTERNATIVE FLOODLAND MANAGEMENT MEASURES CONSIDERED IN PREPARING THE FLOOD MITIGATION PLAN FOR THE CITY OF BROOKFIELD

Alternative		Function(s)	Comments
Major Category	Name		
Structural	Storage	To detain floodwaters upstream of flood-prone reaches for subsequent gradual release	May be accomplished by on-channel reservoirs or by off-channel or underground storage
	Diversion	To divert waters from a point upstream of the floodprone reaches and discharge to an acceptable receiving watercourse outside of the watershed, or to divert floodwaters around flood-prone areas on a completely new alignment	May entail legal problems
	Dikes and floodwalls	To prevent the occurrence of overland flow from the channel to floodland structures and facilities	- -
	Channel modification and enclosure	To convey flood flows through a river reach at significantly lower stages	May be accomplished by straightening, lowering, widening, and otherwise modifying a channel or by enclosure; includes construction of a new length of channel for the purpose of bypassing a reach of a natural stream. This option normally requires environmental enhancement measures as a component to mitigate any negative environmental impacts
	Bridge and culvert alteration or replacement	To reduce the backwater effect of bridges and culverts	May be accomplished by increasing the waterway opening or otherwise substantially altering the crossing or by replacing it
Nonstructural	Reservation of floodlands for recreational and related open space uses	To minimize flood damage by using floodlands for compatible recreational and related open space uses and also to retain floodwater storage and conveyance	May be accomplished through private development, such as development of a golf course, or by public acquisition of the land or by use of an easement
	Floodland regulations	To control the manner in which new urban development is carried out in the floodlands so as to assure that it does not aggravate upstream and downstream flood problems, or to control selected practices by which existing urban or rural lands are managed	May be accomplished through zoning, land subdivision control, sanitary, and building ordinances
	Control of land use outside of the floodlands	To control the manner in which urban development occurs outside of the floodlands so as to minimize the hydrologic impact on downstream floodlands	- -
	Community education programs	To inform and educate citizens regarding personal and private actions by property owners and residents which 1) may adversely affect flood flows and stages or 2) could favorably affect or prevent changes in flood flows and stages in the watershed	May have relationship to aesthetic, recreational, urban utility, or water quality aspects of water resources management in the watershed

Table 6 (continued)

Alternative		Function(s)	Comments
Major Category	Name		
Nonstructural (continued)	Flood insurance	To minimize monetary loss or reduce monetary impact on structure owner	Premiums may be subsidized or actuarially determined
	Lending institution policies	To discourage acquisition or construction of floodprone structures by means of mortgage-granting procedures	- -
	Real-estate-agent policies	To discourage acquisition or construction of floodprone structures by providing flood hazard information to prospective buyers	- -
	Community utility policies	To discourage construction in floodprone areas by controlling the extension of utilities and services	- -
	Emergency programs	To minimize the danger, damage, and disruption from impending flood events	May include installation of remote stage sensors and alarms, road closures, and evacuation of residents
	Structure floodproofing and elevation	To minimize damage to structures by applying a combination of protective measures and procedures on a structure-by-structure basis	- -
	Structure removal	To eliminate damage to existing structures by removing them from floodprone areas	- -
	Channel maintenance	To maintain integrity of flood-stage profiles; to permit unobstructed flow from storm sewers, drainage ditches, and drainage tiles; and to remove potentially troublesome buoyant material	Will not significantly reduce stages of major floods, except as those stages might be influenced by accumulation of buoyant material on the upstream side of bridge waterway openings

Source: SEWRPC.

the proposed project will achieve the reductions in peak flood flows or peak flood stages, or both, that are necessary to abate the flood damages concerned without exacerbating such problems either upstream or downstream of the proposed project.

The alternative should be shown to be economically sound by benefit-cost analysis. While such analysis applied in the classic manner would require that the benefit-cost ratio of a project be greater than one, it must be recognized that other objectives which cannot be directly quantified monetarily, such as providing adequate outlets for municipal stormwater sewers or abating public health and safety hazards resulting from the backup of sanitary sewers surcharged by floodwaters into basements of buildings, may make it politically desirable to construct a project having a benefit-cost ratio of less than one.

The alternatives should be shown at the systems level of planning to be environmentally sound by explicitly considering potential impacts on surface- and groundwater quality and existing and potential aquatic and wildlife habitats and populations. The alternative must also qualify for all legally required regulatory agency approvals.

Only if an alternative meets the foregoing overriding considerations should it be considered for selection as a recommended alternative. Other criteria, such as potential long-term operational maintenance requirements; implementability; compatibility with community open space, recreation, and environmentally sensitive area protection objectives; compatibility with community development objectives; aesthetics; and public support are among the other factors considered in alternative evaluation and selection.

COMPREHENSIVE PLAN PREPARATION

Historically, the watershed has served as the geographic basis for the preparation of comprehensive plans dealing with flooding problems in Southeastern Wisconsin. As noted in Chapter III of this report, SEWRPC, as part of its continuing planning program for the seven-county Southeastern Wisconsin Region, has prepared and adopted comprehensive plans for the two watershed areas that lie partly within the City of Brookfield. SEWRPC adopted its plan for the portion of the Fox River watershed within the State of Wisconsin in 1970 and amended that plan in 1973, 1975, and 1978. SEWRPC adopted its plan for the Menomonee River watershed in 1977 and amended that plan in 1987. In preparing each of these plans, SEWRPC considered a broad range of potential alternative flood mitigation strategies in various combinations, their applicability to specific flooding problems in the watershed involved, and their costs and benefits before selecting a recommended combination of flood mitigation strategies for the final recommended watershed plan.

Alternative Flood Mitigation Strategies for the Wisconsin Portion of the Fox River Watershed

In preparing a comprehensive plan for the portion of the Fox River watershed within the State of Wisconsin, SEWRPC made a concerted effort to offer for public evaluation all physically feasible alternative plan elements which might satisfy one or more agreed-upon watershed development objectives. Each alternative plan element was evaluated insofar as possible in terms of engineering, economic, and legal feasibility and with respect to the satisfaction of the watershed development objectives. The alternative plan elements considered can best be conceptualized in terms of various combinations of land use patterns and water control facilities. A number of alternatives were explored in the preparation of the flood control element of the plan. In preparing this element of the initial plan, in addition to floodland zoning and acquisition of floodland areas for public park and parkway use, SEWRPC considered floodland evacuation, levee and dike construction and channel improvement, storage facility construction, and lake level control facility alternatives.

Alternative Flood Mitigation Strategies for the Menomonee River Watershed

In preparing a comprehensive plan for the physical development of the Menomonee River watershed, SEWRPC made a concerted effort to offer for public evaluation a full range of physically feasible alternative plan subelements which might resolve water resource and water resource-related problems existing at the time of the preparation of the plan and prevent future development of such problems within the framework of agreed-upon watershed development objectives and supporting standards. Each alternative plan subelement was evaluated insofar as possible in terms of technical and economic feasibility, likely environmental impact, financial and legal feasibility, and public acceptability, as well as with respect to the satisfaction of the watershed development objectives.

In a manner similar to that used in the preparation of the plan for the Wisconsin portion of the Fox River watershed, a number of alternatives were explored in the preparation of the floodland management element of the Menomonee River watershed plan. The available floodland management measures from which the floodland management element of the plan was synthesized under the watershed planning process include both structural and nonstructural measures. A total of five structural measures were identified for possible application, either individually or in various combinations, to specific floodprone reaches of the watershed: 1) floodwater storage facilities, 2) floodwater diversion facilities, 3) dikes and floodwalls, 4) major channel modifications, and 5) bridge and culvert modification or replacement. Ten nonstructural measures were likewise identified for possible inclusion in the floodland management element of the plan: 1) reservation of floodlands for recreational and related open space uses, 2) floodland regulations, 3) control of land use outside of the floodlands, 4) flood insurance, 5) lending institution policies, 6) real-estate-agent policies, 7) community utility policies, 8) emergency programs, 9) structure floodproofing and elevation, and 10) structure removal.

Various combinations of structural and nonstructural management measures were evaluated for each of the most floodprone reaches in the watershed, resulting in the selection of a compatible combination of measures for each reach for inclusion in the final recommended watershed plan. Also included in the development of the floodland management element of the watershed plan was an analysis of the impact of possible future land use and floodland development conditions in the watershed on flood flows, flood stages, and flood damages along the watershed stream system. In addition, the plan preparation process included an examination of accessory floodland management measures to meet special needs within the watershed.

Accessory measures considered at the time of initial plan preparation included the maintenance of a skeleton stream-gaging network in the watershed, the periodic cleaning and maintenance of the channel system and bridge and culvert waterway openings, and means of resolving the residual flood damage problem then existing within and immediately upstream of the Menomonee River industrial valley.

SEWRPC's 1987 amendment to the watershed plan, contained in a water resources management plan for the Milwaukee Harbor estuary, included a revision of the regulatory 100-year flood profile and regulatory floodplain boundary for the Menomonee River estuary. The amendment also set forth a new, advisory flood profile and advisory floodplain boundary for the estuary as envisioned under a scenario postulating a long-term rise in the water level of Lake Michigan.

Alternatives in Milwaukee Metropolitan Sewerage District Flood Mitigation Planning

As noted in Chapter III of this report, the MMSD is currently revising and updating its 1990 watercourse system plan. The MMSD's current planning efforts include planning within the Menomonee River watershed, including the City of Brookfield. The MMSD's current watercourse management plan[1] was based in large part upon a 1990 system plan prepared for the MMSD by SEWRPC, which plan, in turn, reflected recommendations set forth in a 1986 policy plan prepared by SEWRPC and adopted by the MMSD. The MMSD used the 1986 policy plan to establish the network of watercourses examined in its planning efforts. In addition, the MMSD policy plan was recently updated to reflect policies regarding MMSD cost-sharing and project eligibility. The MMSD has considered a series of flood control alternatives for watercourses under its jurisdiction.

The flood control alternatives considered by the MMSD for watercourses within the District service area which lies downstream of the City of Brookfield include 1) a "no-action" alternative; 2) detention storage; 3) structure floodproofing and removal; 4) a combination of channelization, structure floodproofing and removal, and bridge alteration; 5) a combination of dikes and floodwalls, structure floodproofing and removal, and bridge alteration; 6) bridge alteration or removal; and 7) a combination of detention storage, bridge alteration, and structure floodproofing and removal. Under the current MMSD floodland management planning, evaluations were made to coordinate and integrate flood mitigation measures for the entire Menomonee River watershed into an integrated flood management plan. All of the alternatives described below as being considered for use in resolving flooding problems within the City of Brookfield have been considered in the context of the potential downstream improvements evaluated by the MMSD in its planning program within the Menomonee River watershed.

RECENT CITY OF BROOKFIELD FLOODLAND SYSTEM PLANNING

In order to develop plans to mitigate flooding problems within the City, detailed stormwater and floodland management planning is needed for each subwatershed area within the City. Such planning is prepared within the context of the comprehensive watershedwide planning noted above.

Stormwater and Floodland Management Plan for Dousman Ditch and Underwood Creek Subwatersheds within the City of Brookfield and the Village of Elm Grove

In addition to the MMSD's current efforts to update its watercourse system plan, recent floodland system planning efforts for the City of Brookfield include a recently completed effort to prepare a stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds[2] within the City as well as within the Village of Elm Grove. As noted in Chapter III of this report, the City joined the Village, SEWRPC, the private engineering and land surveying firm Ruekert & Mielke, Inc., and the Wisconsin Department of Natural Resources in the preparation of this plan, which was carried out within the context of other comprehensive plans applicable to the study area, and was coordinated with the current MMSD system planning efforts described above.

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[1] *Milwaukee Metropolitan Sewerage District,* Phase I Watercourse Management Plan, *August 2000.*

[2] *SEWRPC Community Assistance Planning Report No. 236,* A Stormwater and Floodland Management Plan for the Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove, Waukesha County, Wisconsin, *February 2000.*

To abate existing as well as future stormwater management and flooding problems within the Dousman Ditch and Underwood Creek subwatersheds within the City and the Village, several approaches were considered. These approaches were first evaluated on a conceptual basis, considering the technical feasibility, environmental soundness, applicability, and advantages and disadvantages of each approach. Elements of the most feasible approaches were then incorporated into systems-level alternative stormwater and floodland management plans for the two subwatershed areas.

Alternative approaches to stormwater and floodland management that were considered include conventional conveyance; centralized detention; decentralized or onsite detention; "natural" systems, consisting of vegetation-lined channels, interconnected natural surface depressions, and wetlands; and nonstructural measures, including structure floodproofing or elevation, removal of structures, land use regulations, and open space and floodland preservation. Because the planning area is almost fully developed, the character of the stormwater drainage system has largely been established. Thus, opportunities to significantly alter that system are somewhat limited. However, the existing system does include component management measures characteristic of most of the alternative approaches that were considered.

In the preparation of the plan for the study area, a total of 11 alternative floodland management plans were formulated and evaluated for the abatement of overland flooding damages from storms with recurrence intervals up to and including a 100-year recurrence interval event under planned land use conditions. The principal features of each of the alternative plans considered are summarized in Table 7. The 11 alternatives were each evaluated based upon input obtained from local officials, members of the City-Village Underwood Creek Task Force, and the public; ability to meet agreed-upon principles, objectives, and standards; compatibility with stormwater drainage problem solutions; consideration of the impacts on the downtown business district of the Village of Elm Grove; and ability to meet environmental impact criteria, including wetland impacts; the need for flood easements; control of nonpoint source pollution; impact on the 100-year flood flows and stages; avoidance of construction of a dam and compliance with Chapter NR 333 of the *Wisconsin Administrative Code* regarding dam safety; the impact on the tailwater elevation on tributary culverts and storm sewers during floods; and consideration of benefits and costs.

It should be noted that there is another set of alternatives which were designed and evaluated for stormwater management purposes—both quantity and quality. These alternatives are integrated with the floodland management alternatives in the alternative development and recommended plan selection process.

1998 Stormwater Analysis of the 124th and Congress Streets Area

As noted earlier, the Cities of Brookfield and Wauwatosa did prepare a subwatershed plan for a 2,275-acre portion of the Menomonee River watershed located in those two Cities and in the Village of Butler. The plan addressed flooding, stormwater drainage, and stormwater quality issues. In 1998, the City of Brookfield contracted with Ruekert & Mielke, Inc., to refine the subwatershed plan focussing on the solution to the flooding problems in the City of Brookfield caused by stormwater backups of the drainage system serving the industrial area in the vicinity of 124th Street and Congress Street. As noted in Chapter IV of this report, there are about 25 buildings within the areas flooded due to stormwater backup of roadside ditches and culverts serving and industrial area. The major problem is the result of a culvert with inadequate capacity which conveys stormwater under a Union Pacific Railroad switching yard located just east of the flood problem area.

A number of alternative measures were evaluated, both individually and in combination, to resolve the identified flooding problems. These alternatives included detention facilities, drainage ditch cleaning, storm sewer improvements, and relief culvert installation. In total, eight alternatives consisting of a combination of components were developed and evaluated. The components of each alternative are listed in Table 8.

During 1999, the stormwater and flooding problems in this area and the alternative solutions to those problems were the subject of hearings by the State of Wisconsin Office of the Commissioner of Railroads.

Table 7

PRINCIPAL FEATURES AND COSTS OF ALTERNATIVE FLOOD CONTROL AND ASSOCIATED NONPOINT SOURCE POLLUTION CONTROL PLANS FOR UNDERWOOD CREEK IN THE CITY OF BROOKFIELD AND THE VILLAGE OF ELM GROVE

Alternative	Water Quantity Control Costs							Water Quality Control Costs[a]					Water Quantity and Quality Total Average Annual Cost[b]	Water Quantity and Quality Total Capital Cost
	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total	Average Annual Benefits	Benefit-Cost Ratio	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total		
No. 1-Structure Floodproofing, Elevation, and Removal	Floodproof five houses in Brookfield and 18 in Elm Grove	$ 280,000	--	--	--	--	--	--[c]	--	--	--	--	--	--
	Floodproof four apartment buildings in Elm Grove	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof one commercial building in Brookfield and 15 in Elm Grove	1,000,000	--	--	--	--	--	--	--	--	--	--	--	--
	Acquire and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield and three in Elm Grove	300,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	55,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 1,965,000	$ 125,000	--	$ 125,000	$135,000	1.08	--	--	--	--	--	$ 125,000	$ 1,965,000
No. 2—Acquisition and Removal of Floodprone Structures	Remove eight houses in Brookfield and 21 in Elm Grove	$ 7,210,000	--	--	--	--	--	--[c]	--	--	--	--	--	--
	Remove four apartment buildings in Elm Grove	1,750,000	--	--	--	--	--	--	--	--	--	--	--	--
	Remove one commercial building in Brookfield and 15 in Elm Grove	10,970,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	55,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$19,985,000	$1,269,000	--	$1,269,000	$135,000	0.11	--	--	--	--	--	$1,269,000	$19,985,000
No. 3—Limited Detention Storage with Structure Floodproofing, Elevation, and Removal	Detention basin	$ 1,870,000	--	--	--	--	--	19-acre, 87-acre-foot detention basin	$1,910,000	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--		--	--	--	--	--	--
	Floodproof five houses in Brookfield and 10 in Elm Grove	180,000	--	--	--	--	--	Access roads/ baffles	120,000	--	--	--	--	--

Table 7 (continued)

Alternative	Water Quantity Control Costs							Water Quality Control Costs[a]					Water Quantity and Quality Total Average Annual Cost[b]	Water Quantity and Quality Total Capital Cost
	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total	Average Annual Benefits	Benefit-Cost Ratio	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total		
No. 3 (continued)	Floodproof four apartment buildings in Elm Grove	$ 100,000	--	--	--	--	--	Open channel to convey runoff to pond	$ 100,000	--	--	--	--	--
	Floodproof one commercial building in Brookfield and 15 in Elm Grove	980,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield and three in Elm Grove	300,000	--	--	--	--	--	--	--	--	--	--	--	--
	Acquire and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	50,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 4,060,000[d]	$ 258,000	--[e]	$ 258,000	$135,000	0.52	Total	$2,130,000[f]	$135,000	$9,000	$144,000	$ 402,000	$ 6,190,000
No. 4—Detention Storage with Excavation Minimized, No Wetland Disturbance, and Structure Floodproofing, Elevation, and Removal	Dike and spillway	$ 2,720,000	--	--	--	--	--	19-acre, 87-acre-foot detention basin	$1,910,000	--	--	--	--	--
	Detention basin	1,920,000	--	--	--	--	--		--	--	--	--	--	--
	Access roads/baffles	230,000	--	--	--	--	--	Open channel to convey runoff to pond	100,000	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--		--	--	--	--	--	--
	Easements	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof five houses in Brookfield and 11 in Elm Grove	200,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof four apartment buildings in Elm Grove	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof one commercial building in Brookfield and 14 in Elm Grove	950,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield and one in Elm Grove	180,000	--	--	--	--	--	--	--	--	--	--	--	--
	Acquire and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	50,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 7,030,000[g]	$ 446,000	$10,000	$ 456,000	$135,000	0.30	Total	$2,010,000[h]	$128,000	$9,000	$137,000	$ 593,000	$ 9,040,000
No. 5—Expanded Detention Storage with Excavation Minimized and Structure Floodproofing, Elevation, and Removal	Dike and spillway	$ 2,480,000	--	--	--	--	--	19-acre, 87-acre-foot detention basin	$1,910,000	--	--	--	--	--
	Detention basin	2,000,000	--	--	--	--	--		--	--	--	--	--	--
	Access roads/baffles	340,000	--	--	--	--	--	Open channel to convey runoff to pond	150,000	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	270,000	--	--	--	--	--		--	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--	--	--	--	--	--	--	--

Table 7 (continued)

Alternative	Water Quantity Control Costs							Water Quality Control Costs[a]					Water Quantity and Quality Total Average Annual Cost[b]	Water Quantity and Quality Total Capital Cost
	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total	Average Annual Benefits	Benefit-Cost Ratio	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total		
No. 5 (continued)	Easements	$ 100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof five houses in Brookfield and 11 in Elm Grove	200,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof four apartment buildings in Elm Grove	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof one commercial building in Brookfield and 13 in Elm Grove	890,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield and one in Elm Grove	180,000	--	--	--	--	--	--	--	--	--	--	--	--
	Acquire and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 7,140,000[i]	$ 453,000	$11,000	$ 464,000	$135,000	0.29	Total	$2,060,000[j]	$131,000	$9,000	$140,000	$ 604,000	$ 9,200,000
No. 6—Expanded Detention Storage with Excavation Maximized and Structure Floodproofing, Elevation, and Removal	Dike and spillway	$ 2,130,000	--	--	--	--	--	19-acre, 87-acre-foot detention basin	$1,910,000	--	--	--	--	--
	Detention basin	4,180,000	--	--	--	--	--		--	--	--	--	--	--
	Access roads/baffles	250,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	200,000	--	--	--	--	--	--	--	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof five houses in Brookfield and 11 in Elm Grove	200,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof four apartment buildings in Elm Grove	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof one commercial building in Brookfield and 13 in Elm Grove	890,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield and one in Elm Grove	180,000	--	--	--	--	--	--	--	--	--	--	--	--
	Acquire and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 8,710,000[k]	$ 553,000	$10,000	$ 563,000	$135,000	0.24	Total	$1,910,000[l]	$121,000	$9,000	$130,000	$ 693,000	$10,620,000
No. 7—Expanded Two-Basin Detention Storage with Excavation Minimized and Structure Floodproofing, Elevation, and Removal	South Basin	--	--	--	--	--	--	19-acre, 87-acre-foot detention basin	--	--	--	--	--	--
	Dike and spillway	$ 2,480,000	--	--	--	--	--		--	--	--	--	--	--
	Detention basin	2,000,000	--	--	--	--	--	Open channel to convey runoff to pond	150,000	--	--	--	--	--
	Access roads/baffles	340,000	--	--	--	--	--		--	--	--	--	--	--
	Pilgrim Parkway road grade raise	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--	--	--	--	--	--	--	--
	Easements	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 5,500,000	--	--	--	--	--	--	--	--	--	--	--	--

Table 7 (continued)

Alternative	Water Quantity Control Costs							Water Quality Control Costs[a]					Water Quantity and Quality Total Average Annual Cost[b]	Water Quantity and Quality Total Capital Cost
	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total	Average Annual Benefits	Benefit-Cost Ratio	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total		
No 7 (continued)	North Basin													
	Dike and spillway	$ 1,170,000	--	--	--	--	--	--	--	--	--	--	--	--
	Land acquisition	30,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	20,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 1,220,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproofing, Elevation, and Removal													
	Floodproof four houses in Brookfield and 11 in Elm Grove	$ 190,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof four apartment buildings in Elm Grove	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof one commercial building in Brookfield and 13 in Elm Grove	890,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield and one in Elm Grove	180,000	--	--	--	--	--	--	--	--	--	--	--	--
	Acquire and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 1,590,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 8,310,000[m]	$ 528,000	$14,000	$ 542,000	$135,000	0.25	Total	$2,060,000[j]	$131,000	$9,000	$140,000	$ 682,000	$10,370,000
No. 8—Expanded Two-Basin Detention Storage with Excavation Maximized and Structure Floodproofing, Elevation, and Removal	South Basin	--	--	--	--	--	--	19-acre, 87-acre-foot detention basin	$1,910,000	--	--	--	--	--
	Dike and spillway	$ 2,130,000	--	--	--	--	--		--	--	--	--	--	--
	Detention basin	4,180,000	--	--	--	--	--	--	--	--	--	--	--	--
	Access roads/baffles	240,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise	160,000	--	--	--	--	--	--	--	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 7,060,000	--	--	--	--	--	--	--	--	--	--	--	--
	North Basin													
	Dike and spillway	$ 1,170,000	--	--	--	--	--	--	--	--	--	--	--	--
	Land acquisition	30,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	20,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 1,220,000	--	--	--	--	--	--	--	--	--	--	--	--

Table 7 (continued)

Alternative	Water Quantity Control Costs							Water Quality Control Costs[a]					Water Quantity and Quality Total Average Annual Cost[b]	Water Quantity and Quality Total Capital Cost
	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total	Average Annual Benefits	Benefit-Cost Ratio	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total		
No. 8 (continued)	Floodproofing, Elevation, and Removal													
	Floodproof four houses in Brookfield and 11 in Elm Grove	$ 190,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof four apartment buildings in Elm Grove	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof one commercial building in Brookfield and 13 in Elm Grove	890,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield and one in Elm Grove	180,000	--	--	--	--	--	--	--	--	--	--	--	--
	Acquire and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 1,590,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 9,870,000[n]	$ 627,000	$13,000	$ 640,000	$135,000	0.21	Total	$1,910,000[l]	$121,000	$9,000	$130,000	$ 770,000	$11,780,000
No. 9—Two-Basin Detention Storage with Excavation Minimized, No Wetland Disturbance, and Structure Floodproofing and Elevation	South Basin	--	--	--	--	--	--	19-acre, 87-acre-foot detention basin	$1,910,000	--	--	--	--	--
	Dike and spillway	$ 2,770,000	--	--	--	--	--		--	--	--	--	--	--
	Detention basin	1,920,000	--	--	--	--	--	Open channel to convey runoff to pond	100,000	--	--	--	--	--
	Access roads/baffles	230,000	--	--	--	--	--		--	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--	--	--	--	--	--	--	--
	Easements	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 5,370,000	--	--	--	--	--	--	--	--	--	--	--	--
	North Basin													
	Dike and spillway	$ 130,000	--	--	--	--	--	--	--	--	--	--	--	--
	Land acquisition	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Easements	90,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	55,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 375,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproofing and Elevation													
	Floodproof one house in Brookfield and 11 in Elm Grove	$ 150,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof four apartment buildings in Elm Grove	100,000	--	--	--	--	--	--	--	--	--	--	--	--

Table 7 (continued)

Alternative	Water Quantity Control Costs							Water Quality Control Costs[a]					Water Quantity and Quality Total Average Annual Cost[b]	Water Quantity and Quality Total Capital Cost
	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total	Average Annual Benefits	Benefit-Cost Ratio	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total		
No. 9 (continued)	Floodproofing, Elevation, and Removal (continued)													
	Floodproof one commercial building in Brookfield and 13 in Elm Grove	$ 880,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield and one in Elm Grove	180,000	--	--	--	--	--	--	--	--	--	--	--	--
	Subtotal	$ 1,310,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 7,055,000[o]	$ 448,000	$11,000	$ 459,000	$135,000	0.29	Total	$2,010,000[h]	$128,000	$9,000	$137,000	$ 596,000	$ 9,065,000
No. 10—Limited Dousman Ditch Detention Storage, Bridge and Culvert Modification, and Maximum On-Line Storage with Structure Flood-proofing, Elevation, and Removal	Detention basin	$ 1,870,000	--	--	--	--	--	19-acre, 87-acre-foot detention basin	$1,910,000	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--		--	--	--	--	--	--
	Remove and replace Wall Street and Canadian Pacific railway bridges	810,000	--	--	--	--	--	Access roads/ baffles	120,000	--	--	--	--	--
	Install parallel reinforced concrete box culverts at the Park and Shop, Watertown Plank Road, and the private bridge upstream of Watertown Plank Road	1,850,000	--	--	--	--	--	Open channel to convey runoff to pond	100,000	--	--	--	--	--
	Remove private bridge downstream from Wall Street	5,000	--	--	--	--	--	--	--	--	--	--	--	--
	Provide excavated storage in the Village Park	3,595,000	--	--	--	--	--	--	--	--	--	--	--	--
	Provide excavated storage along Underwood Parkway in Wauwatosa	185,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof five houses in Brookfield and nine in Elm Grove	170,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof four apartment buildings in Elm Grove	105,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof one commercial building in Brookfield and 10 in Elm Grove	560,000	--	--	--	--	--	--	--	--	--	--	--	--
	Elevate two houses in Brookfield	120,000	--	--	--	--	--	--	--	--	--	--	--	--
	Acquire and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	50,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$ 9,900,000[p]	$ 629,000	$ 2,000	$ 631,000	$135,000	0.21	Total	$2,130,000[f]	$135,000	$9,000	$144,000	$ 775,000	$12,030,000

Table 7 (continued)

Alternative	Water Quantity Control Costs							Water Quality Control Costs[a]					Water Quantity and Quality Total Average Annual Cost[b]	Water Quantity and Quality Total Capital Cost
	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total	Average Annual Benefits	Benefit-Cost Ratio	Description	Capital	Amortized Capital[b]	Annual Operation and Maintenance	Total		
No. 11—Limited Dousman Ditch Detention Storage, Underwood Creek Overflow Channel and Diversion, and Compensating Storage with Structure Floodproofing and Removal	Detention basin	$ 1,870,000	--	--	--	--	--	19-acre, 87-acre-foot detention basin	$1,910,000	--	--	--	--	--
	Land acquisition	350,000	--	--	--	--	--		--	--	--	--	--	--
	Construct 4,100-foot-long, grass lined overflow channel	1,400,000	--	--	--	--	--	Access roads/ baffles	120,000	--	--	--	--	--
	Install three parallel 31-foot-long, four-foot-high by 10-foot-wide reinforced concrete box culverts in the overflow channel at Marcella Avenue	85,000	--	--	--	--	--	Open channel to convey runoff to pond	100,000	--	--	--	--	--
	Install two parallel 28-foot-long, five-foot-high by 10-foot-wide reinforced concrete box culverts in the overflow channel at the Village Hall Drive	140,000	--	--	--	--	--	--	--	--	--	--	--	--
	Install 5,400-foot-long, double six-foot-high by seven-foot-wide reinforced concrete box diversion culverts[q]	9,300,000	--	--	--	--	--	--	--	--	--	--	--	--
	Easements for diversion	100,000	--	--	--	--	--	--	--	--	--	--	--	--
	Provide 35 acre-feet of excavated storage in the Village Park	1,500,000	--	--	--	--	--	--	--	--	--	--	--	--
	Provide 14 acre-feet of excavated storage along Underwood Creek in Brookfield upstream of W. North Avenue	640,000	--	--	--	--	--	--	--	--	--	--	--	--
	Purchase six houses in Brookfield for construction of storage area upstream of W. North Avenue	900,000	--	--	--	--	--	--	--	--	--	--	--	--
	Purchase and remove one house in Brookfield	230,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof two houses in Brookfield and two in Elm Grove	45,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof three apartment buildings in Elm Grove[r]	10,000	--	--	--	--	--	--	--	--	--	--	--	--
	Floodproof one commercial building in Brookfield and eight in Elm Grove[s]	320,000	--	--	--	--	--	--	--	--	--	--	--	--
	Pilgrim Parkway road grade raise and associated culverts	$ 50,000	--	--	--	--	--	--	--	--	--	--	--	--
	Total	$16,940,000[t,u]	$1,076,000	$36,000	$1,112,000	$135,000	0.12	Total	$2,130,000[f]	$135,000	$9,000	$144,000	$1,256,000	$19,070,000

Table 7 Footnotes

NOTE: Costs are based upon 1998 Engineering News Record Construction Cost Index = 6,740.

[a] *If during the facilities design phase, it is determined that an impervious liner is required for the wet detention basin, the water quality control cost of Alternative Nos. 3 through 9 would be increased by about $600,000.*

[b] *Amortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.*

[c] *Wet detention basin not included under this alternative plan.*

[d] *The estimated lower limit total cost for this alternative is $3,240,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge. If the buildings to be floodproofed were purchased and demolished, the cost of this alternative plan would increase by about $15,960,000.*

[e] *Operation and maintenance cost assigned to water quality element of the plan.*

[f] *The estimated lower limit total cost for this alternative is $920,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge.*

[g] *The estimated lower limit total cost for this alternative is $4,920,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge. The lower limit cost is also based on the assumption that only five feet of subsurface excavation and backfill, rather than 10 feet, would be needed beneath the dike.*

[h] *The estimated lower limit total cost for this alternative is $800,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge.*

[i] *The estimated lower limit total cost for this alternative is $5,160,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge. The lower limit cost is also based on the assumption that only five feet of subsurface excavation and backfill, rather than 10 feet, would be needed beneath the dike.*

[j] *The estimated lower limit total cost for this alternative is $860,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge.*

[k] *The estimated lower limit total cost for this alternative is $5,880,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge. The lower limit cost is also based on the assumption that only five feet of subsurface excavation and backfill, rather than 10 feet, would be needed beneath the dike.*

[l] *The estimated lower limit total cost for this alternative is $700,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge.*

[m] *The estimated lower limit total cost for this alternative is $5,810,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge. The lower limit cost is also based on the assumption that only five feet of subsurface excavation and backfill, rather than 10 feet, would be needed beneath the dike.*

[n] *The estimated lower limit total cost for this alternative is $6,520,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge. The lower limit cost is also based on the assumption that only five feet of subsurface excavation and backfill, rather than 10 feet, would be needed beneath the dike.*

[o] *The estimated lower limit total cost for this alternative is $4,885,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge. The lower limit cost is also based on the assumption that only five feet of subsurface excavation and backfill, rather than 10 feet, would be needed beneath the dike.*

[p] *The estimated lower limit total cost for this alternative is $9,080,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge. If the buildings to be floodproofed were purchased and demolished, the cost of this alternative plan would increase by about $12,645,000.*

[q] *The overflow channel would be located on existing outlots and in the Village park. Thus, no costs were assigned to obtaining easements for the channel.*

[r] *Three additional apartment buildings in Elm Grove would be on the edge of the 100-year floodplain, but floodproofing would probably not be required.*

[s] *Three additional commercial buildings in Elm Grove would be on the edge of the 100-year floodplain, but floodproofing would probably not be required.*

[t] *The estimated lower limit cost for this alternative is $15,920,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge.*

[u] *If the buildings to be floodproofed were purchased and demolished, the cost of this alternative plan would increase by about $8,345,000.*

Source: SEWRPC.

Table 8

COMPONENTS OF FLOOD CONTROL ALTERNATIVES CONSIDERED FOR THE 124TH AND CONGRESS STREETS INDUSTRIAL AREA

Alternative	Component
Alternative 1	5.5-acre detention pond Ditch maintenance One four-foot by six-foot existing box culvert at the railroad switchyard
Alternative 2	12-acre detention pond Ditch maintenance One four-foot by six-foot existing box culvert at the railroad switchyard
Alternative 3	One four-foot by six-foot existing box culvert at the railroad switchyard One 72-inch proposed culvert at the railroad switchyard
Alternative 4	5.5-acre detention pond Ditch maintenance One four-foot by six-foot existing box culvert at the railroad switchyard One 72-inch proposed culvert at the railroad switchyard
Alternative 4A	5.5-acre detention pond Additional storm sewer One four-foot by six-foot existing box culvert at the railroad switchyard One 72-inch proposed culvert at the railroad switchyard
Alternative 5	12-acre detention pond Ditch maintenance One four-foot by six-foot existing box culvert at the railroad switchyard One 72-inch proposed culvert at the railroad switchyard
Alternative 5A	12-acre detention pond Additional storm sewer One four-foot by six-foot existing box culvert at the railroad switchyard One 72-inch proposed culvert at the railroad switchyard
Alternative 6	Additional storm sewer One four-foot by six-foot existing box culvert at the railroad switchyard

Source: Ruekert & Mielke, Inc.

After taking testimony and holding the necessary hearings on the matter, the Railroad Commissioner issued an order on October 27, 1999, that provided for either Alternative 4A or Alternative 5A to be implemented. Those alternatives both include a detention facility, a new storm sewer along Congress Street in Brookfield through 124th Street ending near the railroad grade in Wauwatosa, and a new 72-inch-diameter culvert through the railroad grade. The City of Brookfield is proceeding to work with the Union Pacific Railroad Company and the City of Wauwatosa to implement Alternative 4A.

Stormwater and Floodland Management Plan for the Fox River Watershed and the Butler Ditch Subwatershed within the City of Brookfield

The City of Brookfield is currently preparing stormwater and floodland management plans for the portion of the Fox River watershed located within the City and for the Butler Ditch subwatershed. This later planning is being conducted cooperatively with the Village of Menomonee Falls. These plans will be similar to the aforementioned plan prepared for the Dousman Ditch and Underwood Creek subwatersheds within the City of Brookfield and the Village of Elm

Grove. Both of these plans will be completed by early in the year 2002. Accordingly, it is anticipated that the alternatives considered will generally be the same as those considered in that plan as summarized in Table 7. As in the case of the latter plan, the preparation of the plans for the portion of the Fox River watershed within the City and for the Butler Ditch subwatershed is being carried out within the context of other comprehensive plans applicable to its study area.

As shown on Map 9 and listed in Appendix D, there are no structures located within the flood hazard areas of the Butler Ditch subwatershed and 10 structures within the flood hazard area of the Fox River watershed. In addition, one floodprone structure within the Fox River watershed (Deer Creek subwatershed) at 375 JoAnne Drive was acquired and removed under a previous flood mitigation project of the City, the Federal Emergency Management Agency (FEMA), and the State Division of Emergency Management. Seven of these structures are located beyond the floodplain and do not experience damage. These structures are identified as being within the floodplain based upon administrative agreement between the City of Brookfield and FEMA because they were constructed on fill and the basement floors are below the regulatory flood stage. These seven structures are not in contact with the floodplain and no further flood mitigation alternatives are needed. Of the remaining three structures identified in the Fox River watershed, one is beyond the floodplain and alternatives related to localized drainage considerations or possibly sanitary sewer backup. These problems are now being evaluated and alternatives developed under ongoing City planning activities. The remaining two structures—one an industrial building and one a commercial building—involve shallow flooding of less than 0.5 foot and separate locations. Thus, floodproofing would seem to be the most logical alternative. The alternatives to resolve these problems will be developed in the aforenoted stormwater and floodland management plan for the Fox River watershed portion of the City.

Chapter VI

FLOOD HAZARD MITIGATION FUNDING SOURCES

Financing of the construction, operation, and maintenance of floodland and stormwater management facilities may be accomplished through the establishment of a stormwater utility; tax-incremental-financing (TIF) districts; local property taxes; reserve funds; general obligation bonds; private-developer contributions, including fees paid to be applied toward construction of regional stormwater management facilities in lieu of providing onsite facilities; State grants or loans; and certain Federal and State programs.

There are thus several options available to the City of Brookfield for the financing of a local flood mitigation program. The identification of potential funding sources, including sources other than solely local-level sources, is an integral part of the implementation of a successful mitigation plan. The following description of funding sources includes those that appear to be potentially applicable for the City of Brookfield as of early in the year 2001. However, funding programs and opportunities are constantly changing. Accordingly, the involved City Department staff have and will continue to become familiar with the potential funding sources and programs that the City and other agencies may utilize as such sources and programs become available. It is intended that this list facilitate the implementation of the flood mitigation activities recommended under the flood mitigation plan for the City set forth in this report. Some of the programs described in this chapter may not be available under all envisioned conditions in the City or to its residents and/or property owners for a variety of reasons, including, for example, eligibility requirements or lack of funds at a given time in Federal and/or State budgets. Nonetheless, the list of sources and programs set forth in this chapter should provide a starting point for identifying possible funding sources for implementing the flood mitigation plan recommended in this report.

FEDERAL EMERGENCY MANAGEMENT AGENCY PROGRAMS

The Federal Emergency Management Agency (FEMA) funds several programs that in the State of Wisconsin are administered through the Wisconsin Department of Military Affairs, Division of Emergency Management. These programs are described below.

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) can provide up to 75 percent of the costs attendant to the floodproofing or acquisition and relocation of floodprone properties, the elevation of structures in compliance with National Flood Insurance Program (NFIP) standards, and other flood control measures, including structural projects, where identified as cost-effective. Under the HMGP, the balance of the costs is shared by the State of Wisconsin (12.5 percent) and the grantee (12.5 percent). Communities in Wisconsin can apply through the State for HMGP funds only after a Presidential disaster declaration is issued. HMGP funds must be applied for within 60 days of the declaration. The State, as HMGP grantee, is responsible for identifying and prioritizing projects. Eligible projects must be included as part of the grantee's flood mitigation plan and must meet cost-benefit criteria established by FEMA. Although State and local units of government are eligible applicants, HMGP funds can be used on private property for eligible projects. The HMGP gives priority to properties identified by FEMA as repetitive-loss properties.

The City of Brookfield has already obtained funds under this program for the purchase and removal of two floodprone structures, and is continuing to use this program. Funding is available through this program only in set amounts. There is no ongoing program for structure acquisition within the City once all HMGP funds are expended.

Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) program can potentially provide up to 75 percent of the costs attendant to the acquisition, relocation, elevation, floodproofing of structures in compliance with NFIP standards. In addition to participating in the NFIP, eligible program applicants must meet cost-benefit criteria established by FEMA. The City of Brookfield is eligible to apply for flood mitigation funding under

the FMA program, but under recent indications, it appears that the amount of funding available under this program has been relatively small. Mitigation of repetitive-loss properties is given a high priority under this program.

Public Assistance Program
FEMA's Public Assistance Program can provide some limited assistance with respect to structure elevation and relocation. For example, if entire portions of a community were to be relocated outside of a floodplain, this program can assist in rebuilding the necessary infrastructure in the new location. Funding under this program is provided for repair of infrastructure damaged during a flood that results in a Presidential disaster declaration. In making repairs to the infrastructure, cost-effective mitigation activities may be included. If a community determines that a badly damaged facility is not to be repaired, the estimated damage amount may be used to fund hazard mitigation measures. The City of Brookfield has obtained funds under this program for public damages arising from the 1997 and 1998 floods.

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT COMMUNITY DEVELOPMENT BLOCK GRANT PROGRAM

Community Development Block Grant (CDBG) programs, funded by the U.S. Department of Housing and Urban Development, are administered by the Wisconsin Departments of Administration and Commerce.

The Community Development Block Grant Emergency Assistance Program is a special program designed by the Wisconsin Department of Administration, Division of Housing & Intergovernmental Relations to assist local units of government in times of emergency. The program is funded with a $2.0 million portion from the Division's annual CDBG allocation, the program provides funds to address housing needs which occur as a direct result of natural or man-made disasters. A local unit of government that has recently experienced a natural or man-made disaster may apply for assistance in addressing housing problems caused by the disaster. Generally, cities, towns, counties, and villages with populations less than 50,000 and all counties, except Milwaukee, Waukesha, and Dane, are eligible to apply. Eligible activities dependent upon the nature of the disaster may include: repair of damage to the dwelling unit, acquisition and demolition of dwellings unable to be repaired, and costs for new housing units to replace those lost in the disaster.

The Small Cities Community Development Block Grant Emergency Program is designed to assist economically distressed smaller communities in the repair or replacement of public facilities that were damaged or destroyed by a natural disaster or a sudden and catastrophic event. The program is administered by the Wisconsin Department of Commerce. Local units of government with populations less than 50,000 and counties, other than Milwaukee, Waukesha, and Dane, are eligible. Eligible activities include demolition and debris removal and disaster-related work on utilities and streets, fire stations and emergency vehicles, and community/senior centers and shelters. The maximum grant amount is $500,000, with a match of one-third of the Community Development Block Grant funds.

U.S. SMALL BUSINESS ADMINISTRATION PROGRAMS

The U.S. Small Business Administration (SBA) provides disaster loans to homeowners and businesses to repair or replace property damaged in a declared disaster. SBA loans are granted only for uninsured losses. Loans may be used to meet required building codes, such as the NFIP requirements. SBA may also provide loans for relocation out of special flood hazard areas when which locations are required by local officials. While SBA's enabling legislation generally prohibits the agency from making disaster loans for voluntary relocations, there are exceptions that can be made, including relocations of homeowners, renters, and business owners out of special flood hazard area when the community is participating in a buyout program. These loans would be limited to the amount necessary to repair or replace the damage at the disaster site. SBA loans may also be used to refinance existing mortgages. Up to 20 percent of the disaster loan can be used for mitigation measures.

U.S. ARMY CORPS OF ENGINEERS

The Corps of Engineers programs are potential sources of funding for implementing the floodland management recommendations of this plan. In order to be eligible for funding, the plan components must meet specific Corps economic feasibility and other criteria. The programs which may be applicable include the following:

- Section 22—Water resources planning assistance—50 percent Federal, 50 percent local cost share

- Section 205—Small flood control projects—Maximum $5 million per project. 75 percent Federal, 25 percent local cost share

- Section 208—Clearing debris and sediment from channels for flood prevention—Maximum $500,000 per project. 75 percent Federal, 25 percent local cost share

- Section 14—Emergency streambank and shoreline protection—Maximum $500,000 per project. 75 percent Federal, 25 percent local cost share

WISCONSIN DEPARTMENT OF NATURAL RESOURCES PROGRAMS

The Wisconsin Department of Natural Resources (WDNR) operates programs that may serve as potential funding sources for the City's flood mitigation efforts. These programs are described below.

Urban Green Space Program

The WDNR's Urban Green Space (UGS) program provides 50 percent matching grants to cities, villages, towns, counties, public inland lake protection and rehabilitation districts, and qualified nonprofit conservation organizations for the acquisition of land. The intent of the program is to provide natural open space within or near urban areas and protect scenic or ecological features. The City of Brookfield is eligible to apply for grants under the UGS program.

Urban Rivers Grants Program

The WDNR's Urban Rivers Grants Program (URGP) provides 50 percent matching grants to municipalities to acquire land or rights to land on or adjacent to rivers that flow through urban areas, in order to preserve or restore urban rivers or riverfronts for the purposes of economic revitalization and the encouragement of outdoor recreational activities. The City of Brookfield is eligible to apply for grants under the URGP.

Stormwater Management Program

The Wisconsin Department of Natural Resources, as of November 2000, administers a Targeted Runoff Management (TRM) grant program provided for under Section 281.65(4c) of the *Wisconsin Statutes.* Grants provided under this program may be used for projects to control nonpoint source pollution from areas of existing urban development and may be available to partially support dual-purpose (quality and quantity) detention ponds or other stormwater management facilities. The TRM program, which involves a competitive grant-seeking process, is currently subject to potential revision and expansion. In addition to funds available from the WDNR, the cost of certain recommended components of the stormwater drainage system may be shared between the City of Brookfield and the Wisconsin Department of Transportation.

LOCAL FUNDING

As previously noted, there are a number of City-based options for funding flood mitigation programs. City staff and elected officials annually review the flood mitigation programs and allocate local funding sources as part of the City budget process. During the years 1999 and 2000, about $1.0 million per year was allocated, as part of the capital improvements programs, for stormwater management and flood mitigation projects. In addition, about $1.5 million was allocated for such projects in the City's general fund budget over that period. These projects are paid for by general obligation bonding supported by the general property tax revenues of the City.

GRANT AWARD ELIGIBILITY, PROGRAM IDENTIFICATION, ACQUISITION, AND ADMINISTRATION

The eligibility and local contribution requirements associated with each of the aforementioned programs varies from program to program. The City of Brookfield Administration Services Department, with support from Departments of Public Works and Planning, shall be the lead agency responsible for identifying potential flood mitigation funding sources. In addition, the City Department of Administration will continue to be the administrative agency responsible for acquiring and administering grant awards attendant to ongoing mitigation efforts in floodplain areas.

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Chapter VII

FLOOD MITIGATION PLAN

This chapter sets forth a description of the flood mitigation plan for the City of Brookfield, the public participation activities and coordination efforts with other agencies undertaken in the preparation of the plan, and strategies for plan implementation and for plan monitoring.

PLAN DESCRIPTION

The flood mitigation plan for the City of Brookfield consists of five elements: an environmentally sensitive lands preservation element, a stormwater management element, a floodland management element, a public information and education element, and a secondary plan element. Each element of the plan is an important component of the City's overall strategy for reducing flood risk and flood damage. As detailed in this chapter, as well as in certain portions of previous chapters of this report, some aspects of the overall plan are already being implemented in the form of existing and ongoing activities being carried out by and in the City that contribute toward realizing the City's flood mitigation goals and objectives.

Environmentally Sensitive Lands Preservation Element

Floodland management regulations and programs perform critical roles toward assuring that flood mitigation efforts are properly implemented. As detailed in Chapter II of this report, the City currently has several pertinent floodland management regulations and programs in place, most notably in the form of City zoning regulations and other ordinances, and environmentally sensitive area and open space preservation policies. The large majority of the environmentally sensitive lands within the City of Brookfield, including wetlands, woodlands, and floodlands, are under protective ownership and/or zoning.

Floodplain Zoning and Wetland Preservation Zoning

City floodland management regulations include the City's floodplain district zoning ordinance and wetland preservation zoning ordinance. The floodplain zoning ordinance is intended to preserve the floodwater conveyance and storage capacity of floodplain areas within the City and to prevent the location of new flood-damage-prone development in flood hazard areas. The wetland preservation zoning ordinance seeks to maintain the stormwater and floodwater storage capacity of wetlands in the City and prohibits certain land uses detrimental to wetland areas. Details regarding each of these ordinances are set forth in Chapter II of this report. Implementation of these ordinances on an ongoing basis is an integral part of the City's flood mitigation strategy.

Environmentally Sensitive Area and Open Space Preservation Actions

As noted in Chapter II of this report, the preservation of environmental corridors and important natural features can assist in the prevention of increased flood flows and associated problems. These areas often include the most significant floodplains and wetlands within a given area. The preservation of wetlands is of particular importance because wetlands often afford natural filtration and floodwater storage. In addition, the intrusion of intensive urban land uses into environmentally sensitive areas may result in the creation of serious and costly problems, such as failing foundations for pavements and structures, wet basements, excessive operation of sump pumps, excessive clearwater infiltration into sanitary sewerage systems, and poor drainage. Destruction of ground cover may result in soil erosion, stream siltation, more rapid runoff, and increased flooding.

The City has taken an active role in preserving the environmental corridors and isolated natural resource areas in the City as part of its park and open space planning program. Under full implementation of the actions envisioned under this program, the important natural resource features in the City would be protected and preserved for resource preservation and other open space purposes, as detailed in Chapter II of this report. The City's planned actions with regard to the preservation of wetlands and floodlands are set forth in Appendix A of this report. The wetland pres-

ervation plan includes a plan component to acquire certain wetlands, including those associated with floodlands, for limited outdoor recreation use, chiefly to provide a proper setting for a recreation trail system proposed in the City's park and open space planning program. In addition, the City plan also recommended that certain other wetlands be acquired as part of the City's system of parks. The floodland preservation plan includes a provision that all undeveloped lands within the 100-year recurrence interval floodplain within the primary environmental corridor be preserved in natural open space uses and, where appropriate, be acquired by the City.

As previously described, the City master plan completed in 1999 provides a guide to development and redevelopment in the City through the year 2020. That plan reinforces the City's previous actions with regard to the preservation of environmental lands. The master plan sets goals and objectives for preservation and appropriate uses of the environmentally sensitive lands which are consistent with the aforenoted wetland and floodland preservation programs.

The actions already taken and planned to be taken by the City with regard to preserving and protecting environmentally sensitive areas and open space areas thus constitute an integral part of the City's flood mitigation efforts.

Stormwater Management Element

Because of the interrelationship between stormwater management and floodland management, stormwater management actions are an important element of the flood mitigation plan. This element of the plan includes stormwater ordinances and related regulations, the development of a citywide stormwater management guide, and specific stormwater management actions developed through detailed subwatershed stormwater management plans.

Stormwater-Related City Regulations

The City, through a series of municipal ordinance provisions currently in place, seeks 1) to control discharges to the municipal separate storm sewer system and 2) to limit storage within and alteration to flood-prone and important stormwater drainage areas in the City. The specific provisions involved are noted in Chapter II of this report. The City has also enacted a construction site erosion control ordinance based on the State of Wisconsin model ordinance. During the year 2000, the City adopted a stormwater management ordinance. The ordinance provides comprehensive procedures and regulations to control the adverse impacts of stormwater runoff from new development and redevelopment. As in the case of the floodplain and wetland preservation zoning provisions noted above, implementation of these ordinances on an ongoing basis is an integral part of the City's flood mitigation strategy.

In addition to the City ordinance provisions noted above, the City has in place several other ordinance provisions pertaining to stormwater management. These provisions include 1) a general erosion control ordinance; 2) guidelines for the dedication of wetlands or the payment of a fee to the City for the purchase of wetlands; 3) a requirement that easements be dedicated for drainageways and watercourses; 4) a requirement that storm sewers and ditches in subdivisions be properly sized for the 10-year storm; 5) a requirement that streets and highways not obstruct natural drainageways; 6) a requirement that new or modified buildings have adequate drainage and not obstruct natural drainageways; and 7) a requirement regarding setbacks for all structures adjacent to a waterway not covered by City floodplain regulations. These regulations are designed to help assure that stormwater does not increase downstream flows or aggravate flooding problems.

City of Brookfield Stormwater Management Guide

As noted in Chapter III of this report, a stormwater management guide for the City of Brookfield was prepared in 1995. This guide, prepared with partial financial assistance from the Wisconsin Department of Natural Resources (WDNR), was adopted by the City in October 1995 as the first step in a systematic, multiyear citywide stormwater management program. The guide identifies critical stormwater management and stormwater management-related issues to be addressed following the time of its preparation and adoption; sets forth measures to respond to those issues concerning the quantity and quality of stormwater runoff, environmental protection, finance, equitable sharing of costs, maintenance, public information and education, ordinances, and master planning for subwatersheds; and sets forth a practical program for implementing those recommendations. The City stormwater management guide, whose nine stormwater management goals are noted in Chapter III of this report, has served as an important precursor to the detailed subwatershed-level planning efforts undertaken by the City in cooperation with other units and agencies of government and other concerned parties and described in more detail below. The guide sets

forth an implementation schedule, or sequence of actions; identifies units and agencies of government responsible for implementing the actions; and suggests how the implementation program could be financed. The subwatershed areas within the City were prioritized on a "need" basis for stormwater management action, with the Lower Menomonee River subwatershed given the highest priority and the South Branch of Underwood Creek subwatershed given the lowest priority. The City has continued to implement its adopted 1995 stormwater management guide through the development of detailed subwatershed stormwater and floodland management planning programs.

Year 2020 Master Plan

As previously described, the City's 2020 master plan includes specific stormwater management goals and objectives which reinforce the planning programs described in this chapter. The master plan recognizes the previously completed and ongoing planning and programming as the means to resolve flooding and stormwater management problems in the City.

Stormwater Management Measures Resulting from 1998 Stormwater Analysis of Area Surrounding Intersection of 124th Street and Congress Street (Lower Menomonee River subwatershed)

A stormwater analysis of a 500-acre industrial area surrounding the intersection of 124th Street and Congress Street and encompassing portions of the City of Brookfield, the City of Wauwatosa, and the Village of Butler was performed by Woodward-Clyde Consultants and refined by the firm Ruekert & Mielke, Inc., in February 1998. This analysis was performed to determine 1) the approximate severity of flooding affecting the area involved and 2) the most practical and economical of a series of eight alternatives considered for abating the flooding in that area. The analysis has resulted in the identification of a preferred alternative. This alternative involves 1) the construction of a 5.5-acre detention facility located west of 127th Street and north of Lisbon Road; 2) installation of a 72-inch culvert to be located 300 feet north of and running parallel to an existing four-foot-by-six-foot box culvert crossing the Union Pacific Railroad's Butler Yard; and 3) addition of a storm sewer located parallel to Congress Street that would connect the envisioned detention facility to the envisioned 72-inch culvert. The invert of the proposed 72-inch storm sewer would be approximately six and one-half feet lower than the existing box culvert in order to ensure proper drainage of all storm sewer systems tributary to it. Implementation of the preferred alternative is expected to reduce total property-value loss in the City of Brookfield resulting from the two-year, 10-year, and 100-year recurrence interval floods from, respectively, approximately $7.5 million, $9.0 million, and $11.0 million to $0, $1.0 million, and $3.0 million. The preferred alternative has an estimated capital cost of $3.3 million and an annual operation and maintenance cost of $150,000.

The City of Brookfield has adopted the analysis report and the preferred alternative. During 1999, the stormwater and flooding problems in this area and the alternative solutions to those problems were the subject of hearings by the State of Wisconsin Office of the Commissioner of Railroads. After taking testimony and holding the necessary hearings on the matter, the Railroad Commissioner issued an order that provided for either of two alternatives to be implemented. Those alternatives both include a detention facility, a new storm sewer along Congress Street in Brookfield through 124th Street ending near the railroad grade in Wauwatosa, and a new 72-inch-diameter culvert through the railroad grade. The City of Brookfield is proceeding to work with the Union Pacific Railroad Company and the City of Wauwatosa to implement the City's preferred alternative.

Stormwater Management Recommendations of Plan for Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove

As noted in previous chapters of this report, a comprehensive stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds in the City of Brookfield and the Village of Elm Grove has recently been completed. This plan was prepared cooperatively by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and Ruekert & Mielke, Inc., in cooperation with the City, the Village, and the WDNR. This plan consists of three elements: a water quality management element, a stormwater drainage element, and a floodland management element. The water quality management and the stormwater drainage of the subwatershed-level plan are combined into a single set of stormwater management actions.

The components of the stormwater management measures and their estimated capital and annual operation and maintenance costs are summarized in Table 9. The stormwater management measures are summarized in graphic form on Map 11. Detailed descriptions

Table 9

COMPONENTS AND COSTS OF SUBWATERSHED-LEVEL STORMWATER AND FLOODLAND MANAGEMENT PLAN ELEMENTS FOR THE DOUSMAN DITCH AND UNDERWOOD CREEK SUBWATERSHEDS IN THE CITY OF BROOKFIELD AND THE VILLAGE OF ELM GROVE

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a]	
			Capital[b]	Annual Operation and Maintenance[c]
Stormwater Drainage Plan Element				
Dousman Ditch Subwatershed				
--	City of Brookfield	1. Dousman Ditch detention basin	--[d]	--
Culvert and Storm Sewer Conveyance Plan				
DD-2	City of Brookfield	1. DD2C1—Replace 44 feet of 18-inch CMP culvert under Patricia Lane at Calhoun Drive with 21-inch CMP	$ 3,000	$ 0
		2. DD2C11—Replace 108 feet of 21-inch concrete storm sewer in Lucy Circle north of Evergreen Court with 24-inch RCP storm sewer	11,000	0
		Subtotal DD-2	$ 14,000	$ 0
Culvert, Roadside Swale, and Storm Sewer Conveyance Plan				
DD-5	Village of Elm Grove	1. DD5C24—Replace 165 feet of 18-inch CMP culvert on N. Verdant Drive north of Watertown Plank Road with twin 22-inch by 36-inch CMPA	$ 40,000	$ 90
		2. DD5C25—Retain the 38-foot-long, twin 33-inch by 49-inch CMPA culverts crossing N. Verdant Drive north of Watertown Plank Road and add two parallel 22-inch by 36-inch CMPA	10,000	40
		3. DD5C33/A—Retain one 257-foot-long, 48-inch CMP culvert and one 257-foot-long, 36-inch CMP north of Watertown Plank Road east of Pilgrim Parkway and add a 270-foot-long, four-foot by eight-foot reinforced concrete (RC) box	210,000	70
		4. DD5C33D/E—Retain the two 52-foot-long, 49-inch by 33-inch CMPA culvert crossing Pilgrim Parkway north of Watertown Plank Road and add a 60-foot-long, four-foot by eight-foot RC box	45,000	20
		Subtotal	$ 305,000	$ 220
	City of Brookfield	5. DD5C26—Replace 30 feet of 15-inch CMP culvert crossing Mt. Vernon Avenue west of Westmoor Drive with 18-inch CMP	$ 2,000	$ 0
		Subtotal DD-5	$ 307,000	$ 220
Storm Sewer Conveyance Plan				
DD-7	Village of Elm Grove	1. DD7C3—Replace 318 feet of 24-inch storm sewer east of Briaridge Court with 27-inch by 44-inch RCPA storm sewer	$ 55,000	$ 0
		2. DD7C4—Replace 295 feet of 24-inch corrugated polyethylene storm sewer west of Briaridge Court with 27-inch by 44-inch RCPA storm sewer	51,000	0
		Subtotal DD-7	$ 106,000	$ 0

Table 9 (continued)

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a] Capital[b]	Estimated Cost[a] Annual Operation and Maintenance[c]
Storm Sewer Conveyance and Building Acquisition Plan[e]				
DD-8 Indianwood/ Onondaga Area	City of Brookfield	1. DD8C5—Replace 400 feet of 24-inch corrugated polyethylene storm sewer with 27-inch by 44-inch RCPA storm sewer	$ 70,000	$ 0
		2. House and lot acquisition	270,000	0
		3. Lot and ditch regrading and landscaping	15,000	500
		Subtotal	$ 355,000	$ 500
Storm Sewer and Swale Conveyance with Structure Floodproofing Plan				
DD-8 Victoria Circle North Area	Village of Elm Grove	1. Replace 340 feet of 15-inch-diameter CMP storm sewer in Victoria Circle North with 1,400 feet of 18-inch-diameter PVC storm sewer and add a 50-foot-long, 12-inch-diameter PVC wetland outlet with a backwater gate	$ 97,000	$ 600
		2. Construct a 570-foot-long, grass-lined, trapezoidal overflow swale with one vertical on four horizontal side slopes and a 60-foot-wide bottom	50,000[f]	300
		3. Floodproof two houses on the north side of Victoria Circle North	23,000	200
		Subtotal	$ 170,000	$ 1,100
		Subtotal DD-8	$ 525,000	$ 1,600
Storm Sewer and Culvert Conveyance Plan				
DD-9	City of Brookfield	1. DD9C18—Replace 630 feet of 18-inch CMP storm sewer on Gebhardt Road between Church View Drive and Alverno Drive with 27-inch RCP storm sewer	$ 72,000	$ 0
		2. DD9C12—Replace 247 feet of twin 21-inch storm sewer at Eileen Court north of Gebhardt Road with twin 27-inch RCP storm sewer	56,000	0
		Subtotal	$ 128,000	$ 0
	Village of Elm Grove	3. DD9C30—Replace 42 feet of 18-inch CMP culvert crossing Pilgrim Parkway north of Gebhardt Road with 30-inch CMP	$ 4,000	$ 0
		Subtotal DD-9	$ 132,000	$ 0
		Subtotal Dousman Ditch Subwatershed	$ 1,084,000	$ 1,820
Underwood Creek Subwatershed				
Storm Sewer and Culvert Conveyance Plan				
UC-1	City of Brookfield	1. UC-1C37—Replace 59 feet of 15-inch storm sewer crossing Kings View Lane north of Burleigh Boulevard with 18-inch by 29-inch RCPA storm sewer	$ 7,000	$ 0
		2. UC-1C19—Replace 389 feet of 16-inch-diameter cast iron storm sewer east of Smith Drive south of Luella Drive with 18-inch RCP storm sewer	34,000	0
		3. Replace 44 feet of 18-inch CMP culvert crossing Smith Drive south of Luella Drive with 18-inch RCP culvert	4,000	0

Table 9 (continued)

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a] Capital[b]	Estimated Cost[a] Annual Operation and Maintenance[c]
UC-1 (continued)	City of Brookfield (continued)	4. Replace 175 feet of eight-inch concrete storm sewer located south of Luella Drive and east of Smith Drive with 18-inch RCP storm sewer	$ 15,000	$ 0
		5. UC-1C29—Replace 166 feet of 18-inch storm sewer in drainage easement north of Burleigh Road east of Marti Lane with 21-inch storm sewer	16,000	0
		Subtotal UC-1	$ 76,000	$ 0
Culvert Conveyance Plan				
UC-2	City of Brookfield	1. UC-2C7—Replace 41 feet of 18-inch storm sewer crossing Hillsdale Drive north of W. North Avenue with 21-inch RCP storm sewer	$ 4,000	$ 0
		Subtotal UC-2	$ 4,000	$ 0
Storm Sewer Conveyance Plan				
UC-4	City of Brookfield	1. UC4C17—Replace 530 feet of 18-inch RCP storm sewer in drainage easement between San Raphael Drive and Pomona Road with 24-inch RCP storm sewer	$ 55,000	$ 0
		2. UC4C18—Replace 210 feet of 21-inch RCP storm sewer in drainage easement between Pomona Road and Underwood Creek with 27-inch RCP storm sewer	24,000	60
		Subtotal UC-4	$ 79,000	$ 60
Storm Sewer Conveyance Plan				
UC-5	City of Brookfield	1. UC5C30—Replace 249 feet of 18-inch RCP storm sewer in Westwood Drive with 24-inch-high by 38-inch-wide RCP HE storm sewer	$ 40,000	$ 0
		2. UC5C30A—Retain 195 feet of 21-inch RCP storm sewer in Westwood Drive and add a parallel 24-inch diameter RCP storm sewer at a slope of 0.10 percent	20,000	110
		3. UC5C31—Retain 148 feet of 24-inch RCP storm sewer in a drainage easement between Westwood Drive and the North Branch of Underwood Creek and add a parallel 24-inch diameter RCP storm sewer	15,000	100
		4. UC5C21-Retain 95 feet of 24-inch RCP storm sewer in the intersection of Crestview Circle and Westwood Drive and add a parallel 24-inch diameter RCP storm sewer	10,000	80
		5. UC5C22-Retain 200 feet of 27-inch RCP storm sewer in a drainage easement between the intersection of Westwood Drive and Crestview Circle and the North Branch of Underwood Creek and add a parallel 27-inch diameter RCP storm sewer	23,000	110
		Subtotal UC-5	$ 108,000	$ 400

Table 9 (continued)

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a]	
			Capital[b]	Annual Operation and Maintenance[c]
Storm Sewer Conveyance Plan				
UC 6	City of Brookfield	1. UC6C4—Rep/lace the existing 587-foot-long, 24-inch-diameter CMP in San Marcos Drive and in a drainage easement between San Marcos Drive and Sunny View Lane with 27-inch RCP storm sewer	$ 62,000	$ 0
		2. UC6C5—Replace the 51-foot-long, 27-inch-diameter CMP and the 77-foot-long, 27-inch-diameter RCP in Sunny View Lane with 27-inch-diameter RCP laid at a constant slope	15,000	0
		3. UC6C7—Replace the 310-foot-long, 27-inch-diameter RCP in a drainage easement northeast of East View Court with 30-inch-diameter RCP storm sewer	39,000	0
		4. UC6C8—Replace the 243-foot-long, 30-inch-diameter storm sewer in the drainage easement west of San Juan Trail and in San Juan Trail with 36-inch-diameter RCP storm sewer	36,000	0
		5. UC6C9—Replace the 201-foot-long, 36-inch-diameter RCP in the drainage easement between San Juan Trail and the North Branch with 42-inch-diameter RCP storm sewer	36,000	0
		6. Replace the 206-foot-long, 12-inch-diameter RCP storm sewer in a drainage easement west of San Juan Trail and north of W. Burleigh Road with 21-inch-diameter RCP storm sewer	20,000	0
		7. Replace the 226-foot-long, 15-inch-diameter RCP storm sewer in San Juan Trail and in an easement to the east of San Juan Trail with 27-inch-diameter RCP storm sewer	26,000	0
		8. Replace the 258-foot-long, 12-inch-diameter RCP storm sewer flowing from south to north on the east side of Lilly Road opposite BEHS with 18-inch-diameter RCP storm sewer	22,000	0
		9. Replace the 260-foot-long, 15-inch-diameter RCP storm sewer flowing from north to south on the east side of Lilly Road opposite BEHS with 18-inch-diameter RCP storm sewer	23,000	0
		10. UC6C10—Replace the 607-foot-long, 18-inch-diameter RCP storm sewer in Lilly Road and the BEHS north parking lot with 21-inch-diameter RCP storm sewer	60,000	0
		11. UC6C11—Replace the 425-foot-long, 18-inch-diameter RCP storm sewer in the BEHS north parking lot with 30-inch-diameter RCP storm sewer	53,000	0
		12. UC6C12—Replace the 305-foot-long, 18-inch-diameter RCP storm sewer in the BEHS north parking lot with 36-inch-diameter RCP storm sewer	46,000	0
		13. UC6CAA—Replace the 44-foot-long, 12-inch-diameter CMP storm sewer under Lilly Road just south of W. Burleigh Road with a 15-inch CMP	2,000	0
		Subtotal UC-6	$ 440,000	$ 0

Table 9 (continued)

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a]	
			Capital[b]	Annual Operation and Maintenance[c]
Storm Sewer Conveyance and Pumping Plan				
UC-7	City of Brookfield	1. Replace the existing 250-foot-long, 12-inch-diameter RCP storm sewer in Carson Court with 27-inch-high by 44-inch-wide RCPA storm sewer	$ 48,000	$ 0
		2. Replace the 25-foot-long, 12-inch-diameter RCP along Oakhill Lane northeast of Carson Court with 23-inch-high by 36-inch-wide RCPA storm sewer	4,000	0
		3. Replace the 67-foot-long, 15-inch-diameter polyvinyl chloride (PVC) storm sewer under Oakhill Lane near its intersection with Thornapple Lane with 23-inch-high by 36-inch-wide RCPA storm sewer	11,000	0
		4. Replace the 63-foot-long, 15-inch-diameter RCP under Carson Court at its intersection with Oakhill Lane with 27-inch-high by 44-inch-wide RCPA storm sewer	12,000	0
		5. UC7C12—Replace the 539-foot-long, 18-inch-diameter storm sewer along Oakhill Lane southwest of Carson Court with 27-inch-high by 44-inch-wide RCPA	103,000	0
		6. UC7C12B—Replace the 464-foot-long, 18-inch-diameter RCP along Oakhill Lane with 31-inch-high by 51-inch-wide RCPA storm sewer	103,000	0
		7. UC7C12C—Replace the 33-foot-long, 30-inch-diameter CMP under Lilly Road at Oakhill Lane with 31-inch-high by 51-inch-wide RCPA storm sewer	7,000	60
		8. UC7D7A—Modify the 400-foot-long swale along the north side of Oakhill Lane between Lilly Road and El Rancho Drive to have a parabolic shape approximating a trapezoid with a seven-foot-wide bottom and one vertical on two horizontal side slopes	6,000	200
		9. UC7C10—Replace the 48-foot-long, 24-inch-diameter CMP culvert under El Rancho Drive at its intersection with Oakhill Lane with a double 31-inch-high by 51-inch-wide RCPA	21,000	0
		10. Construct stormwater pumping station with 100 cfs pumping capacity	1,830,000	8,500
		11. 600 feet of 48-inch-diameter RCP force main	130,000	200
		12. 755 feet of 48-inch-diameter storm sewer draining to pump station	160,000	200
		13. 500 feet of 54-inch-diameter storm sewer draining to pump station	120,000	100
		14. Grade lot at 13830 Adelaide Lane to drain toward street	10,000	0
		Subtotal UC-7	$ 2,565,000	$ 9,200

Table 9 (continued)

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a]	
			Capital[b]	Annual Operation and Maintenance[c]
Storm Sewer and Culvert Conveyance Plan				
UC-8	Village of Elm Grove	1. UC-8C3—Replace the 77-foot-long, 21-inch-diameter CMP culvert under Fairhaven Boulevard at Wrayburn Road with a 27-inch-high by 44-inch-wide RCPA culvert	$ 15,000	$ 0
		2. UC-8C7—Replace the 44-foot-long, 18-inch-diameter CMP culvert crossing the southern lanes of Wrayburn Road between Arrowhead Court and Fairhaven Boulevard with an 18-inch-high by 29-inch-wide RCPA culvert	6,000	0
		3. UC-8C13—Replace the 53-foot-long, 18-inch-diameter CMP under the southern lanes of Wrayburn Road on the east side of Arrowhead Court with a 27-inch diameter CMP culvert	4,000	0
		4. UC-8C14—Replace the 51-foot-long, 18-inch-diameter CMP under the northern lanes of Wrayburn Road on the east side of Arrowhead Court with a 24-inch-high by 35-inch-wide CMPA culvert	6,000	0
		5. UC-8C16—Replace the 52-foot-long, 18-inch-diameter CMP under the northern lanes of Wrayburn Road on the west side of Arrowhead Court with two, parallel 18-inch-high by 29-inch-wide RCPA culverts	13,000	100
		6. UC-8C25—Replace the 221-foot-long, 18-inch-diameter CMP culvert along the west side of Hollyhock Lane at its intersection with Wrayburn Road with an 18-inch-high by 29-inch-wide CMPA culvert	23,000	0
		7. UC-8C26—Replace the 180-foot-long, parallel double 33-inch-high by 48-inch-wide CMPA culverts in the Wrayburn Tributary under Hollyhock Lane with two, parallel 36-inch-high by 58-inch-wide RCPA culverts	91,000	0
		8. Replace the 630-foot-long, 15-inch-high by 21-inch-wide CMPA located outside of the public right-of-way between Lee Court and Wrayburn Road with a 42-inch-diameter CMP	73,000	0
		9. Replace the 82-foot-long, 12-inch-diameter CMP storm sewers under Wrayburn Road and San Fernando Drive with a 15-inch-diameter RCP storm sewer	7,000	0
		10. Replace the 327-foot-long, 15-inch-diameter CMP storm sewer along the north side of Wrayburn Road between San Fernando Drive and the Wrayburn Tributary with a 15-inch-diameter RCP storm sewer	28,000	0
		11. Install 410 feet of 15-inch-diameter RCP storm sewer from the south side of Lloyd Street through and San Fernando Drive and in an easement to be obtained between San Fernando Drive and a tributary to the Wrayburn Tributary[f]	41,000	200

Table 9 (continued)

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a]	
			Capital[b]	Annual Operation and Maintenance[c]
UC-8 (continued)	Village of Elm Grove (continued)	12. Install 65 feet of 15-inch-diameter RCPA storm sewer, followed by 230 feet of 18-inch-diameter RCP storm sewer, followed by 315 feet of 18-inch-high by 29-inch-wide RCPA storm sewer from the north side of Garfield Street to the north side of Lloyd Street, across San Fernando Drive, and then in an easement to be obtained between San Fernando Drive and the tributary to the Wrayburn Tributary[g]	$ 89,000	$ 400
		Subtotal	$ 396,000	$ 700
	City of Brookfield	13. UC-7C21[h]—Replace the 74-foot-long, 21-inch-diameter RCP culvert under N. 131st Street on the north side of W. North Avenue with two, parallel 24-inch-diameter RCP culverts	$ 11,000	$ 0
		Subtotal UC-8	$ 407,000	$ 700
Storm Sewer and Culvert Conveyance Plan				
UC-9	Village of Elm Grove	1. UC9-C1—Replace the 44-foot-long, 18-inch-diameter CMP culvert under Fairhaven Boulevard at Elmhurst Parkway with a 24-inch-high by 35-inch-wide CMPA culvert	$ 5,000	$ 0
		2. UC9-C2—Replace the 31-foot-long, 18-inch-diameter CMP culvert under Shady Lane at Elmhurst Parkway with a 24-inch-high by 35-inch-wide CMPA culvert	4,000	0
		3. UC9-C3—Replace the 37-foot-long, 21-inch-diameter CMP culvert under Blue Ridge Boulevard at Elmhurst Parkway with a 29-inch-high by 42-inch-wide CMPA culvert	5,000	0
		4. UC9-C6—Replace the 438-foot-long, 27-inch-high by 42-inch-wide CMPA storm sewer located between the northern and southern lanes of Elmhurst Parkway just west of Notre Dame Boulevard with a 36-inch-high by 58-inch-wide RCPA storm sewer	111,000	$ 0
		5. UC9-C8 and UC9C11—Replace the 962-foot-long, 27-inch-high by 42-inch-wide CMPA storm sewer located between the northern and southern lanes of Elmhurst Parkway between Church Street and Legion Drive with a 40-inch-high by 65-inch-wide RCPA storm sewer	284,000	0
		Subtotal UC-9	$ 409,000	$ 0
Structure Floodproofing Plan				
UC-10	Village of Elm Grove	1. Regrade and repave eastern driveway area at Elm Grove apartment complex to floodproof basement parking garages at two apartment buildings	$ 45,000	$ 0
		Subtotal UC-10	$ 45,000	$ 0
Culvert and Swale Conveyance Plan				
UC-11	Village of Elm Grove	1. UC11C8—Replace the 176-foot-long, combination 15-inch-diameter RCP and 24-inch-diameter CMP culvert located west of Grandview Drive with a 27-inch-high by 44-inch-wide RCPA culvert	$ 34,000	$ 0

Table 9 (continued)

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a]	
			Capital[b]	Annual Operation and Maintenance[c]
UC-11 (continued)	Village of Elm Grove (continued)	2. UC11C10—Replace the 55-foot-long, 21-inch-high by 36-inch-wide CMPA culvert under Kurtis Drive with two parallel 205-foot-long, 27-inch-high by 44-inch-wide RCPA culverts	$ 79,000	$ 100
		3. UC11C14—Replace the 37-foot-long, 15-inch-diameter CMP culvert under Sunny Slope Road north of Watertown Plank Road with a 23-inch-high by 36-inch-wide RCPA culvert	6,000	0
		Subtotal UC-11	$ 119,000	$ 100
Culvert Conveyance Plan				
UC-13	Village of Elm Grove	1. UC13C3—Replace the 48-foot-long, 15-inch-diameter CMP culvert under Gremoor Drive just west of N. 124th Street with an 18-inch-diameter CMP culvert	$ 3,000	$ 0
		2. UC13C4—Replace the 100-foot-long, 18-inch-diameter CMP culvert under Walnut Street just west of N. 124th Street with a 14-inch-high by 22-inch-wide RCPA culvert	16,000	0
		Subtotal UC-13	$ 19,000	$ 0
UC-14	Village of Elm Grove	1. Replace the 55-foot-long, 12-inch-diameter CMP culvert on the west side of Longwood Avenue at Centa Lane with a 24-inch-diameter CMP culvert	$ 4,000	$ 0
		2. Replace the 35-foot-long, 18-inch-diameter CMP culvert under Longwood Avenue at Centa Lane with a 24-inch-diameter CMP culvert	3,000	0
		3. UC14C1—Replace the 332-foot-long, 15- and 18-inch-diameter CMP culvert along the north side of Centa Lane between Longwood Avenue and Woodside Lane with a 24-inch-diameter CMP culvert	26,000	0
		Subtotal UC-14	$ 33,000	$ 0
		Subtotal Underwood Creek Subwatershed	$ 4,304,000	$10,460
--	--	Subtotal Stormwater Drainage Plan Element	$ 5,388,000	$12,280
Water Quality Management Plan Element				
Dousman Ditch Detention Basin with Increased Street Sweeping in Critical Areas				
--	City of Brookfield	1. 19-acre, 87-acre-foot detention basin	$ 3,780,000[i]	$ 9,000
--	City of Brookfield	2. Access roads/baffles	120,000	0
--	City of Brookfield	3. Open channel to convey runoff to pond	100,000	0
--	City of Brookfield	4. Land acquisition	90,000[j]	0
--	Village of Elm Grove City of Brookfield	5. Street sweeping (23 curb-miles)[k]	6,000	7,000
--	Village of Elm Grove City of Brookfield	6. Site-specific controls for new development or redevelopment	--[l]	--[l]
--	Village of Elm Grove City of Brookfield	7. Development or expansion of public education programs and resultant improved urban "housekeeping" practices	--[l]	--[l]
--	Village of Elm Grove City of Brookfield	8. Strict enforcement of construction erosion control ordinances	--[l]	--[l]

Table 9 (continued)

Hydrologic Unit	Location of Component	Project and Component Designation and Description	Estimated Cost[a]	
			Capital[b]	Annual Operation and Maintenance[c]
--	Village of Elm Grove City of Brookfield	9. Limited streambank stabilization	--[l]	--[l]
--	Village of Elm Grove City of Brookfield	10. Reduced application of street sand	--[l]	--[l]
--	--	Subtotal Water Quality Management Plan Element	$ 4,096,000	$16,000
Floodland Management Plan Element				
Limited Dousman Ditch Detention Storage, Underwood Creek Overflow Channel and Diversion, and Compensating Storage with Structure Floodproofing and Removal				
--	City of Brookfield	1. Dousman Ditch detention basin	--[i]	--
--	City of Brookfield	2. Land acquisition	$ 260,000[j]	--
--	Village of Elm Grove	3. Construct 4,100-foot-long, grass lined overflow channel[m]	1,400,000	--
--	Village of Elm Grove	4. Install three parallel 31-foot-long, four-foot-high by 10-foot-wide reinforced concrete box culverts in the overflow channel at Marcella Avenue	85,000	--
--	Village of Elm Grove	5. Install two parallel 28-foot-long, five-foot-high by 10-foot-wide reinforced concrete box culverts in the overflow channel at the Village Hall Drive	$ 140,000	--
--	Village of Elm Grove	6. Install 5,400-foot-long, double six-foot-high by seven-foot-wide reinforced concrete box diversion culverts	9,300,000	--
--	Village of Elm Grove	7. Easements for diversion culverts	100,000	--
--	Village of Elm Grove	8. Provide 35 acre-feet of excavated storage in the Village Park	1,500,000	--
--	City of Brookfield	9. Provide 14 acre-feet of excavated storage along Underwood Creek in Brookfield upstream of W. North Avenue	640,000	--
--	City of Brookfield	10. Purchase six houses in Brookfield for construction of storage area upstream of W. North Avenue	900,000	--
--	Village of Elm Grove City of Brookfield	11. Floodproof one house in Brookfield and two in Elm Grove[n]	35,000	--
--	Village of Elm Grove	12. Floodproof three apartment buildings in Elm Grove[o]	10,000	--
--	Village of Elm Grove City of Brookfield	13. Floodproof one commercial building in Brookfield and seven in Elm Grove[p]	215,000	--
--	Village of Elm Grove	14. Pilgrim Parkway road grade raise and associated culverts	50,000	--
--	City of Brookfield	15. Clearwater Drive culvert replacement, road grade raise, and provision of one acre-foot of floodwater storage volume[q]	120,000	--
--	--	Subtotal Floodland Management Plan Element	$14,755,000[r,s]	$36,000
--	--	Total Stormwater and Floodland Management Plan	$24,239,000	$64,280

Table 9 (continued)

[a]*Costs based upon 1998 Engineering News-Record Construction Cost Index = 6,740.*

[b]*Includes 35 percent for engineering, administration, and contingencies.*

[c]*Operation and maintenance costs are listed as $0 when an existing component is replaced with a component having similar operation and maintenance costs.*

[d]*The costs for this detention basin are assigned to the water quality and floodland management elements of the plan, but the basin is listed here to emphasize that it is also an important component of the stormwater drainage system.*

[e]*The possibility of installing a large culvert to convey flows up to the peak rate of runoff from a 100-year storm and to eliminate the need to acquire a house and lot could be considered in the plan implementation/final design stage.*

[f]*Includes removal of abandoned tennis court at Pilgrim Park Middle School.*

[g]*Easement assumed to cost $5,000.*

[h]*Most runoff tributary to this culvert drains to Hydrologic Unit UC-8, but some drains to UC-7, thus, it was assigned to UC-7 when it was designated.*

[i]*A cost of $1,800,000 was assigned to the detention basin under the water quantity control element in Chapter V of SEWRPC Community Assistance Planning Report No. 236, A Stormwater and Floodland Management Plan for the Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove, Waukesha County, Wisconsin, December 1999, to enable a consistent comparison with the other floodland management alternatives. However, because it would be necessary to spend the $1,800,000 to construct the wet basin for quality control, it is assigned to the water quality management plan element in this table. If during the facilities design stage it is determined that an impervious liner is required for the wet detention basin, this cost would be increased by about $600,000.*

[j]*Land acquisition cost apportioned between floodland and water quality management elements.*

[k]*Sweep every four weeks between April 1 and October 31.*

[l]*No specific costs estimated.*

[m]*The overflow channel would be located on six existing outlots and in the Village park. It would be necessary to obtain easements from the owners of the outlots. The cost of such easements would be determined in negotiations between the Village and the owners. Thus, no costs were assigned to obtaining those easements.*

[n]*One house to be floodproofed under Alternative No. 11 as described in Chapter V of SEWRPC Community Assistance Planning Report No. 236, A Stormwater and Floodland Management Plan for the Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove, Waukesha County, Wisconsin, December 1999, would be eliminated from the floodplain through implementation of recommended stormwater drainage measures. One house to be purchased under Alternative No. 11 has already been purchased and removed. Thus, no costs are included here for those two houses.*

[o]*Three additional apartment buildings in Elm Grove would be on the edge of the 100-year floodplain, but floodproofing would probably not be required.*

[p]*Three additional commercial buildings in Elm Grove would be on the edge of the 100-year floodplain, but floodproofing would probably not be required. One commercial building in Elm Grove that was to be floodproofed under Alternative No. 11 in Chapter V of SEWRPC Community Assistance Planning Report No. 236, A Stormwater and Floodland Management Plan for the Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove, Waukesha County, Wisconsin, December 1999, has been purchased (American Legion Hall). Thus, no cost is included here for that building.*

[q]*See the later section of this chapter that describes alternative and recommended plants for the Clearwater Drive area.*

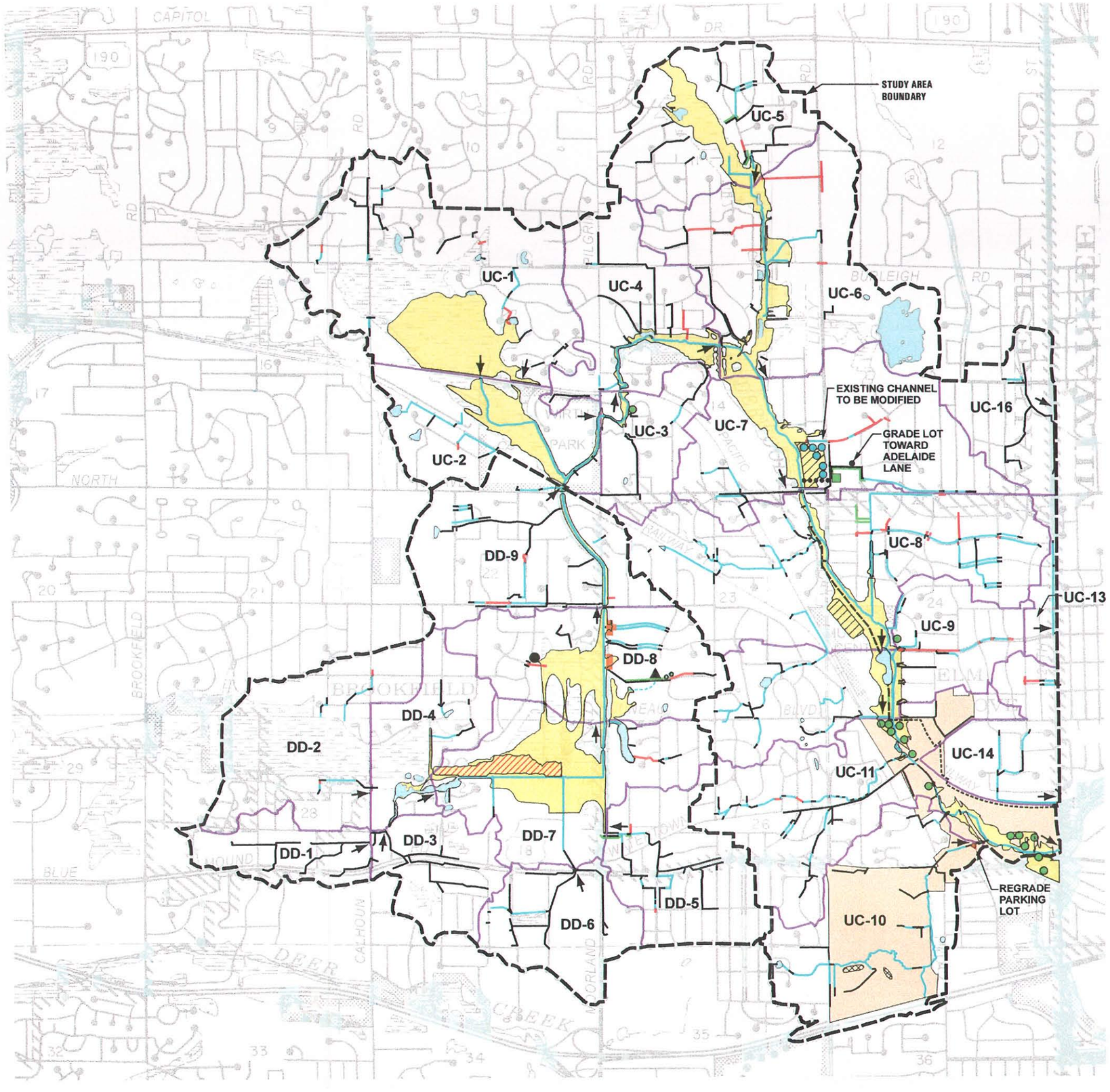
[r]*The estimated lower limit cost for this alternative is $13,815,000. That cost is based on an optimistic assumption that the excavated soil could be used as topsoil and/or peat for landscaping and would be hauled from the site free of charge.*

[s]*If the buildings to be floodproofed were purchased and demolished, the cost of this alternative plan would increase by about $7,450,000.*

Source: SEWRPC.

Map 11

STORMWATER AND FLOODLAND MANAGEMENT PLAN ELEMENTS FOR THE DOUSMAN DITCH AND UNDERWOOD CREEK SUBWATERSHEDS IN THE CITY OF BROOKFIELD AND THE VILLAGE OF ELM GROVE



CORPORATE LIMIT BOUNDARY

HYDROLOGIC UNIT BOUNDARY

DD-1 HYDROLOGIC UNIT IDENTIFICATION

HYDROLOGIC UNIT OUTLET

100-YEAR RECURRENCE INTERVAL FLOODPLAIN PLANNED LAND USE AND PROPOSED CHANNEL CONDITIONS

PROPOSED DUAL-PURPOSE WET DETENTION BASIN

EXISTING STORM SEWER OR CULVERT

EXISTING OPEN CHANNEL OR FLOW PATH

PROPOSED REPLACEMENT STORM SEWER OR CULVERT

PROPOSED STORM SEWER OR CULVERT

PROPOSED GRASS-LINED TRAPEZOIDAL SWALE

PROPOSED BACKWATER GATE

PROPOSED 48-INCH FORCE MAIN

PROPOSED OVERFLOW CHANNEL

PROPOSED DIVERSION BOX CULVERT

PROPOSED ROAD GRADE RAISE

EXISTING DRY DETENTION BASIN

PROPOSED COMPENSATING STORAGE AREA

SWEEP STREETS EVERY FOUR WEEKS FROM APRIL 1 TO OCTOBER 31

BUILDING PROPOSED TO BE FLOODPROOFED

BUILDING PROPOSED TO BE PURCHASED FOR CONSTRUCTION OF FLOODWATER STORAGE AREA

ACQUIRE ONE HOUSE AND LOT NEAR ONONDAGA CIRCLE AND INDIANWOOD DRIVE AND REGRADE LOT TO ENABLE RUNOFF TO BE CONVEYED TO THE WETLAND ALONG DOUSMAN DITCH

PROPOSED STORMWATER PUMPING STATION

SURFACE WATER

NOTE THE STUDY AREA CONSISTS OF THE ENTIRE DOUSMAN DITCH SUBWATERSHED AND THE WAUKESHA COUNTY PORTION OF THE UNDERWOOD CREEK SUBWATERSHED.

Source: SEWRPC.

of the stormwater management actions for each of the hydrologic units in the subwatershed areas involved are set forth in the subwatershed-level plan report.

The stormwater management recommendations call for the following: 1) construction of a dual-purpose wet detention basin with a permanent pond area of 19 acres along the upper reach of Dousman Ditch west of Pilgrim Parkway and north of Wisconsin Avenue extended, in the City of Brookfield; 2) provision of new or replacement culverts and storm sewers at potential problem areas throughout the watershed areas concerned; 3) limited swale modification; 4) acquisition of one house and the associated lot on Indianwood Drive in the City; 5) floodproofing of two houses along Victoria Circle North in the Village of Elm Grove; 6) construction of a stormwater pumping station with a capacity of 100 cubic feet per second along the east side of Lilly Road, north of W. North Avenue, in the City; and 7) increased sweeping of about 23 curb-miles of streets in critical land use areas in both the City and the Village. The wet detention basin would provide about 23 acre-feet of floodwater storage and an 87-acre-foot permanent pond for the control of nonpoint source pollution, and would provide control of runoff from areas of planned development. Nonpoint source pollution from all remaining areas to be developed and from areas to be redeveloped in the subwatershed areas concerned would also be controlled through a series of actions including 1) construction of the recommended detention basin, 2) construction site erosion control measures, and 3) site-specific "best management" practices to reduce the washoff of pollutants. Implementation of the stormwater management plan element would provide controls on runoff from about 73 percent of the critical land uses in the subwatershed areas concerned and all areas of new development or redevelopment.

In addition to providing control of nonpoint source pollution, the detention basin would also serve as an important component of the area's stormwater drainage system. Full implementation of the recommended stormwater drainage measures would provide the subwatershed areas involved with a minor stormwater drainage system adequate to convey and/or store runoff from storms with recurrence intervals up to and including 10 years and to generally provide an acceptable level of traffic service and access to property during such storms. Implementation of the recommended drainage measures would also avoid direct flooding of inhabited buildings during storms with recurrence intervals up to and including 100 years. The selected measures would help to mitigate, but not eliminate, flooding of basements due to sanitary sewer backup. Other measures directed toward reduction of infiltration and inflow to sanitary sewers would be required to fully alleviate sanitary sewer backup problems in the subwatershed areas involved.

The estimated capital cost of implementing the subwatershed-level stormwater management plan elements for the Dousman Ditch and Underwood Creek subwatersheds within the City of Brookfield and the Village of Elm Grove is about $9.5 million (see Table 9). Of this total estimated capital cost, about $4.1 million would be incurred in implementing the water quality management plan element and about $5.4 million would be incurred in implementing the stormwater drainage plan element. The estimated annual operation and maintenance costs of implementing the subwatershed-level stormwater management plan elements for the areas involved is about $28,000.

Stormwater Management Recommendations of Other Subwatershed-Level Plans for City of Brookfield

In addition to the aforementioned detailed subwatershed-level stormwater management measures for the area surrounding the intersection of 124th Street and Congress Street in the Cities of Brookfield and Wauwatosa and the Village of Butler and for the Dousman Ditch and Underwood Creek subwatershed areas in the City of Brookfield and the Village of Elm Grove, the City of Brookfield has begun the preparation of similarly detailed subwatershed-level stormwater management plans for the remainder of the City. These work efforts, like the completed subwatershed-level efforts, will refine and detail the adopted watershed plans for the Fox River and Menomonee River watersheds with regard to the subwatershed areas involved. These plans are expected to be completed by early in 2002.

Floodland Management Element

In addition to the other elements of the flood mitigation plan for the City of Brookfield, mitigation measures specifically pertaining to floodland management are included under the plan. These measures constitute the floodland management element of the plan.

Floodland Management Recommendations of Plan for Dousman Ditch and Underwood Creek Subwatersheds in the City of Brookfield and the Village of Elm Grove

As noted above, the recently completed comprehensive stormwater and floodland management plan for the Dousman Ditch and Underwood Creek subwatersheds in the City of Brookfield and the Village of Elm Grove includes a floodland management element. This element contains a series of recommended floodland management measures for the subwatershed areas involved.

The components of the floodland management measures and their estimated capital and annual operation and maintenance costs are summarized in Table 9. The recommended floodland management components are shown in detail on Maps 12 and 13 and in summary form in the context of the overall subwatershed-area-specific recommendations for the areas involved on Map 11. Detailed descriptions of the recommended floodland management actions for the subwatershed areas involved are set forth in the subwatershed-level plan report.

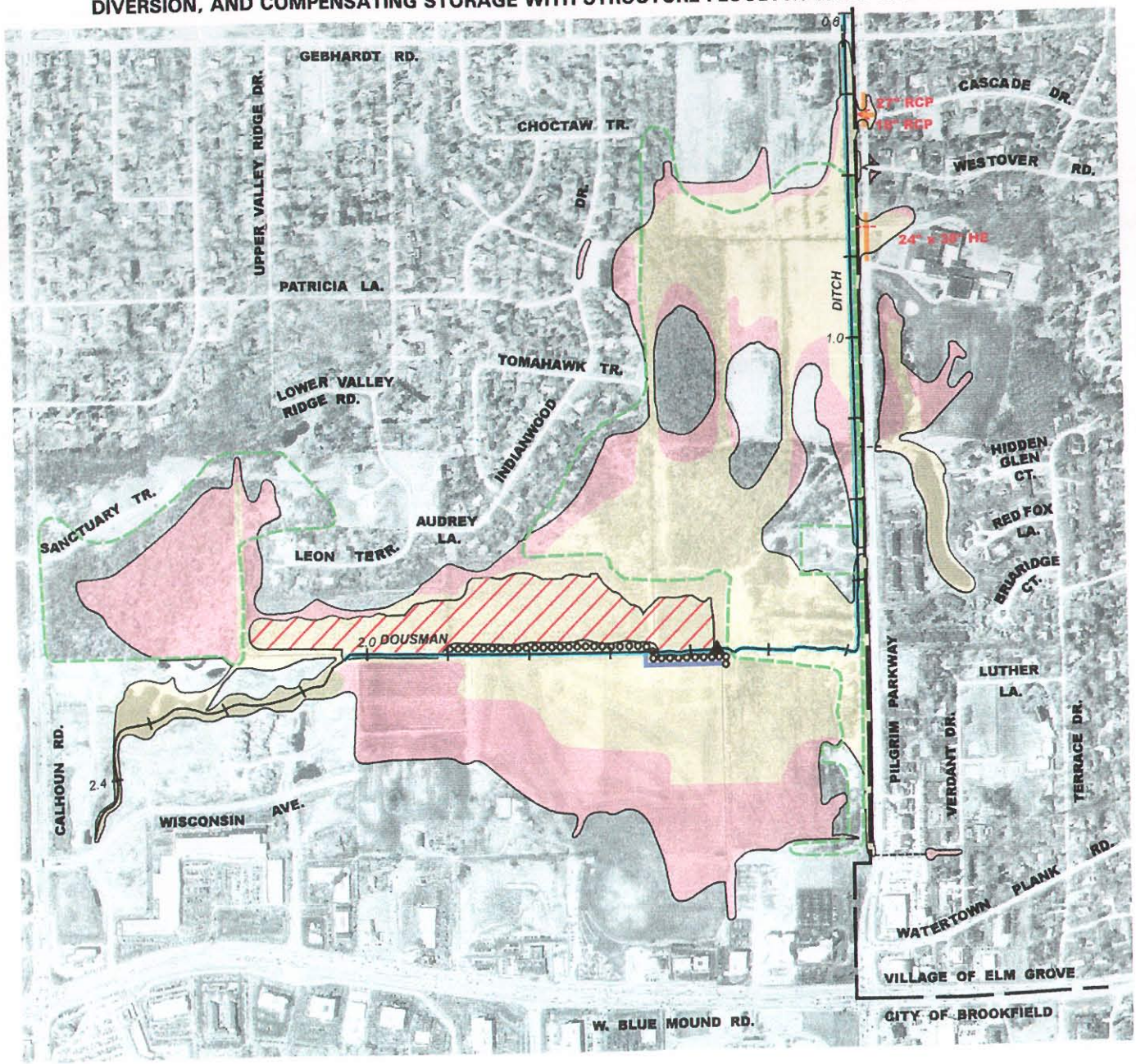
As shown on Maps 11, 12, and 13, the floodland management recommendations call for the following: 1) construction of the aforementioned dual-purpose basin providing 23 acre-foot of floodwater storage, with a permanent pond area of 19 acres, along Dousman Ditch west of Pilgrim Parkway in the City of Brookfield; 2) provision of about 14 acre-feet of floodwater storage volume in the eastern overbank of Underwood Creek in the City, immediately northwest of the intersection of W. North Avenue and Lilly Road; 3) purchase and removal of six houses located east of Underwood Creek in the City to enable construction of the aforementioned 14-acre-foot detention storage area; 4) provision of about 35 acre-feet of floodwater storage volume in the northern portion of the Elm Grove Village Park in the Village; 5) construction of a 4,100-foot-long overflow channel along the western overbank of Underwood Creek, or possibly channel overbank lowering, from near the intersection of Mt. Kisco Drive and Underwood River Parkway to Juneau Boulevard in the Village; the channel would flow into, and out of, the existing pond in Elm Grove Village Park; 6) provision of three parallel, 31-foot-long, four-foot-high-by-10-foot-wide reinforced concrete box culverts at the Marcella Avenue crossing of the recommended overflow channel in the Village; 7) provision of two parallel, 28-foot-long, five-foot-high-by-10-foot-wide reinforced concrete box culverts at the Village Hall Drive crossing of the overflow channel in the Village; 8) provision of a 5,400-foot-long double six-foot-high-by-seven-foot-wide reinforced concrete box culvert diversion from Juneau Boulevard through the downtown portion of the Village of Elm Grove to a location about 450 feet east of the Waukesha-Milwaukee county line; 9) floodproofing, or purchase and removal, of one single-family residence in the City of Brookfield and two in the Village of Elm Grove, three apartment buildings in the Village, and one commercial building in the City and seven in the Village; 10) replacement of culverts and raising of the road grade at the crossing of Clearwater Drive over Underwood Creek, in the City of Brookfield; and 11) provision of about one acre-foot of floodwater storage volume near Clearwater Drive.

Additional actions associated with the Dousman Ditch detention basin include 1) acquisition of about 115 acres of land in the vicinity of the detention basin; 2) the raising of about 360 feet of Pilgrim Parkway south of Gebhardt Road an average of about 0.9 foot to avoid inundation of the roadway during a 100-year flood; and 3) replacement of the existing northern 24-inch-diameter corrugated metal pipe culvert under Pilgrim Parkway at Cascade Drive with a 50-foot-long, 27-inch-diameter reinforced concrete pipe culvert, replacement of the southern corrugated metal pipe culvert there with a 53-foot-long, 18-inch-diameter reinforced concrete pipe culvert, and replacement of the existing 27-inch-high-by-43-inch-wide corrugated metal pipe arch culvert under Pilgrim Parkway at the northern entrance to Pilgrim Park Middle School with a 60-foot-long, 24-inch-high-by-38-inch-wide reinforced concrete horizontal elliptical pipe culvert.

Full implementation of the floodland management actions recommended for the subwatershed areas involved would eliminate structure flood damages due to direct overland flooding along Underwood Creek for floods up to and including the 100-year recurrence interval flood event under planned land use and channel conditions. Damages due to street flooding would be reduced, but not eliminated, by implementation of the actions. In addition, sanitary sewer basement backup problems would be reduced, but not eliminated, by implementation of the actions in the

Map 12

FLOODLAND MANAGEMENT PLAN ALONG DOUSMAN DITCH-LIMITED DOUSMAN DITCH DETENTION STORAGE, UNDERWOOD CREEK OVERFLOW CHANNEL AND DIVERSION, AND COMPENSATING STORAGE WITH STRUCTURE FLOODPROOFING AND REMOVAL



0.5 EXISTING CHANNEL CENTERLINE AND RIVER MILE STATIONING

100-YEAR RECURRENCE INTERVAL FLOODPLAIN PLANNED LAND USE AND EXISTING CHANNEL CONDITIONS

100-YEAR RECURRENCE INTERVAL FLOODPLAIN PLANNED LAND USE AND PROPOSED CHANNEL CONDITIONS

PROPOSED WET DETENTION BASIN

PROPOSED WET DETENTION BASIN BAFFLE AND/OR SANITARY SEWER MANHOLE ACCESS ROAD

EXISTING OPEN CHANNEL

PROPOSED OPEN CHANNEL TO CONVEY RUNOFF FROM SUBBASIN DD-6 TO POND

EXISTING CULVERT

EXISTING WETLAND BOUNDARY

PROPOSED OUTLET STRUCTURE

PROPOSED GRADE RAISE

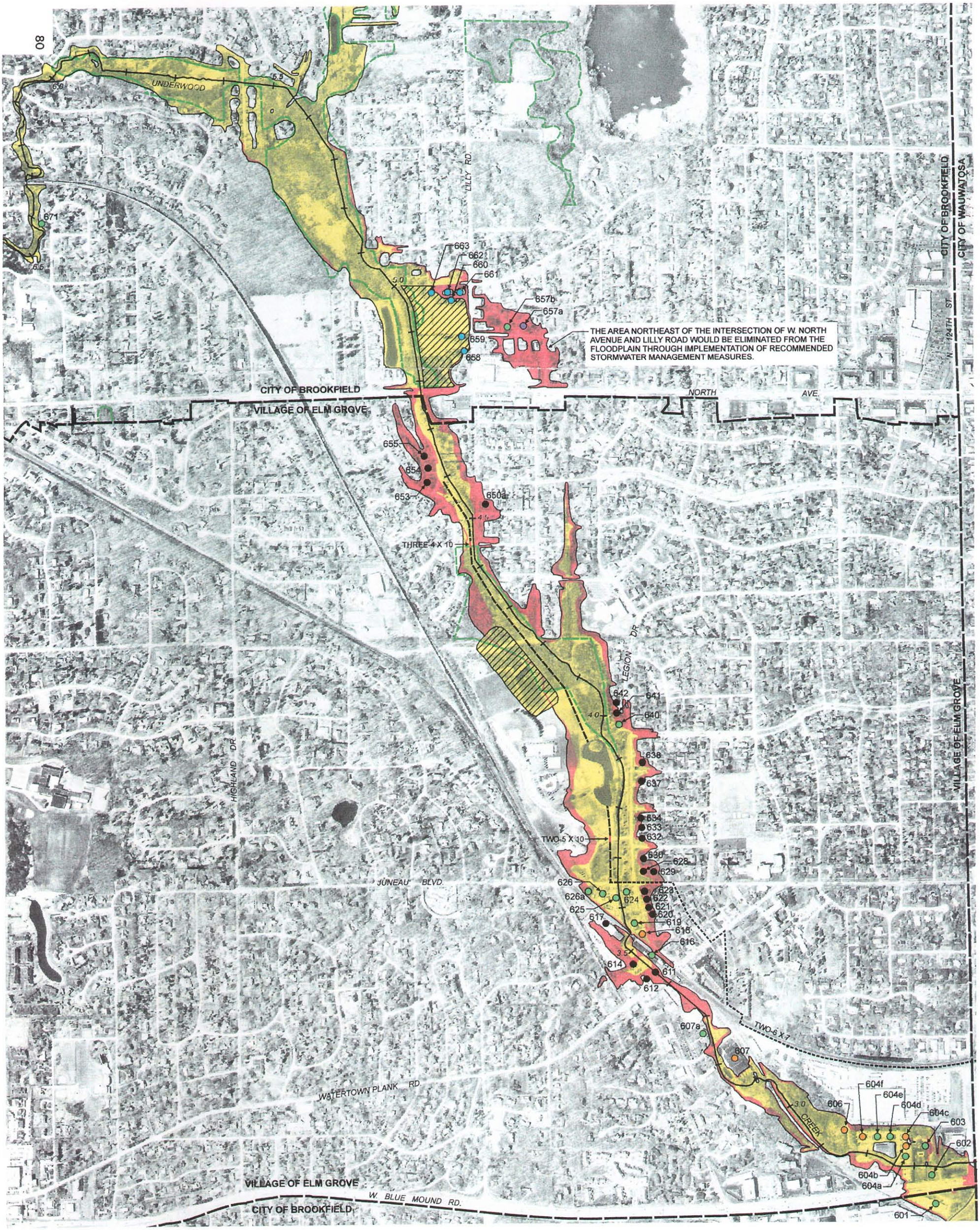
27 PROPOSED REPLACEMENT CULVERT (SIZE IN INCHES)

HE REINFORCED CONCRETE HORIZONTAL ELLIPTICAL PIPE

RCP REINFORCED CONCRETE PIPE

GRAPHIC SCALE
0 500 1000 FEET

Source: SEWRPC.



Map 13

FLOODLAND MANAGEMENT PLAN ALONG UNDERWOOD CREEK-LIMITED DOUSMAN DITCH DETENTION STORAGE, UNDERWOOD CREEK OVERFLOW CHANNEL AND DIVERSION, AND COMPENSATING STORAGE WITH STRUCTURE FLOODPROOFING AND REMOVAL

- 0.5 — EXISTING CHANNEL CENTERLINE AND RIVER MILE STATIONING
- 100-YEAR RECURRENCE INTERVAL FLOODPLAIN—PLANNED LAND USE AND EXISTING CHANNEL CONDITIONS
- 100-YEAR RECURRENCE INTERVAL FLOODPLAIN—PLANNED LAND USE AND PROPOSED CHANNEL CONDITIONS
- EXISTING WETLAND BOUNDARY
- 607a — BUILDING DESIGNATION
- BUILDING PROPOSED TO BE FLOODPROOFED
- BUILDING PROPOSED TO BE REMOVED
- BUILDING PROPOSED TO BE PURCHASED FOR CONSTRUCTION OF FLOODWATER STORAGE AREA
- BUILDING NO LONGER IN FLOODPLAIN DUE TO IMPLEMENTATION OF RECOMMENDED FLOOD CONTROL MEASURES
- BUILDING NEAR EDGE OF FLOODPLAIN, FLOODPROOFING MAY NOT BE REQUIRED
- PROPOSED BOX CULVERT (SIZE IN FEET)
- PROPOSED DIVERSION BOX CULVERT (SIZE IN FEET)
- PROPOSED OVERFLOW CHANNEL
- PROPOSED COMPENSATING STORAGE AREA

NOTE: IF IT IS DETERMINED DURING THE FINAL DESIGN STAGE THAT CERTAIN BUILDINGS CANNOT BE FLOODPROOFED, IT IS RECOMMENDED THAT THOSE BUILDINGS BE ACQUIRED AND REMOVED.

GRAPHIC SCALE
0 500 1000 FEET

Source: SEWRPC.

absence of other measures directed toward reduction of infiltration and inflow to sanitary sewers.

The 100-year flood stage along Dousman Ditch in the City of Brookfield upstream of the envisioned detention basin outlet structure would be reduced by from 0.4 foot to 1.9 feet compared to the existing 100-year flood stage. Along Dousman Ditch between the basin outlet and Gebhardt Road in the City of Brookfield and the Village of Elm Grove, the 100-year flood stage would be decreased by about one foot. This reduction would marginally improve drainage of adjacent developed lands in the City and the Village, including the Indianwood and Onondaga area in the City, where significant stormwater drainage problems exist.

Implementation of the recommended actions would also reduce the 100-year flood stage by from 0.7 foot to 3.5 feet in the reach of Underwood Creek in the Village of Elm Grove extending from the Waukesha-Milwaukee county line to W. North Avenue and by from 0.2 foot to 0.3 foot in the 0.5-mile-long reach of Underwood Creek in the City of Brookfield upstream from W. North Avenue. The provision of about 72 acre-feet of floodwater storage volume as described above would avoid flood-flow and flood-stage increases in the City of Wauwatosa downstream of the Village of Elm Grove during floods with recurrence intervals from two through 100 years.

The number of buildings located in the 100-year floodplain of Underwood Creek within the subwatershed areas involved would be reduced from 57 to 22 under full implementation of the floodland management plan element. As shown in Tables 10 and 11, 51 of the 57 buildings are located in the Village of Elm Grove and seven are located within the City of Brookfield.

As shown in Table 9, the estimated total capital cost of implementing the subwatershed-level floodland management plan element for the Dousman Ditch and Underwood Creek subwatersheds within the City of Brookfield and the Village of Elm Grove is about $14.8 million, assuming it would be possible to floodproof all of the buildings remaining in the floodplain. Assuming an annual interest rate of 6 percent, a project life and amortization period of 50 years, and annual operation and maintenance costs of $36,000 per year, the average annual cost of implementing the floodland management actions for the area involved is about $973,000.

If, during the final design stage of implementation, it were determined that all of the buildings that are recommended to be floodproofed could not be floodproofed, those buildings would be purchased and removed. If all of the buildings concerned were purchased and removed, the estimated cost of implementing the floodland management actions for the area could increase to about $22.2 million. Therefore, it would be realistic to expect that the cost of implementing the recommended floodland management actions would be within a range from about $14.8 million to about $22.2 million.

Tables 12 and 13 set forth estimated 100-year recurrence interval flood flows at selected locations in the subwatershed areas involved under planned land use and existing channel conditions and under planned land use and planned channel conditions.

Floodland Management Plan of Other Subwatershed-Level Plans for City of Brookfield

In addition to the aforementioned detailed subwatershed-level floodland management recommendations for the Dousman Ditch and Underwood Creek subwatershed areas in the City of Brookfield and the Village of Elm Grove, the City of Brookfield has begun the preparation of similarly detailed subwatershed-level floodland management recommendations for the remainder of the City. These work efforts, like the completed subwatershed-level efforts, will refine and detail the adopted watershed plans for the Fox River and Menomonee River watersheds with regard to the subwatershed areas involved.

As previously noted, flooding-related problems in the Butler Ditch and Fox River subwatersheds are not as severe as in the Dousman Ditch and Underwood Creek subwatersheds. As shown in Appendix D, there are 10 structures being considered in the Fox River subwatershed and none in the Butler Ditch subwatershed. However, in all cases, the structures in the Fox River watershed are either not severe, or are caused by drainage and/or sanitary sewer backup. These problems are being addressed in ongoing City planning programs. Under those programs alternatives resolving the identified problems relating to flooding, drainage, and sanitary sewer backup will be developed. These planning efforts will be completed in 2002. Flood control alternatives will include acquisition and removal, floodproofing, and other appropriate measures.

Table 10

BUILDINGS ALONG UNDERWOOD CREEK THAT ARE WITHIN THE 100-YEAR RECURRENCE INTERVAL FLOODPLAIN IN THE VILLAGE OF ELM GROVE[a]

Building Number	Type of Building
602	Single-family residence
603	Commercial
604a	Apartments
604b	Apartments
604c	Apartments
604d	Apartments
604e	Apartments
604f	Apartments
606	Commercial
607	Commercial
607a	Commercial
608	Commercial
611	Commercial
612	Commercial
613	Commercial
614	Commercial
615	Single-family residence
616	Commercial
617	Commercial
618	Commercial
619	Commercial
620	Single-family residence
621	Single-family residence
622	Single-family residence
623	Single-family residence
624	Commercial
625	Commercial
626	Commercial
626a	Commercial
628	Single-family residence
629	Single-family residence
630	Single-family residence
632	Single-family residence
633	Single-family residence
634	Single-family residence
635	Single-family residence
636	Single-family residence
637	Single-family residence
638	Single-family residence
640	Single-family residence
641	Single-family residence
642	Single-family residence
644	Single-family residence
649	Single-family residence
650	Single-family residence
650a	Single-family residence
653	Single-family residence
654	Single-family residence
655	Single-family residence
656	Single-family residence
700	Single-family residence

[a]*Under planned land use and existing channel conditions.*

Source: SEWRPC.

Table 11

BUILDINGS ALONG UNDERWOOD CREEK THAT ARE WITHIN THE 100-YEAR RECURRENCE INTERVAL FLOODPLAIN IN THE CITY OF BROOKFIELD[a]

Building Number	Type of Building
601	Commercial
657b	Single-family residence
658	Single-family residence
659	Single-family residence
660	Single-family residence
663	Single-family residence
671	Single-family residence

[a]*Under planned land use and existing channel conditions.*

Source: SEWRPC.

Public Information and Education Element

Public information, education, and participation constitute an integral aspect of the City of Brookfield's flood mitigation and related efforts. The City has engaged and continues to engage in informational and educational efforts oriented toward resolving the flooding and related stormwater drainage and sanitary sewer backup problems in the City. This element has been carried out under three subelement activities which are to be continued. These three subelements include the Citywide Flood Task Force activity, public education activities, and public information programming and coordination associated with detailed stormwater and floodland management plans.

Citywide Flood Task Force Activity

The first subelement involves the creation and activity of the Citywide Flood Task Force as described in Chapter II of this report. This Task Force is charged with researching problems, identifying needs, and presenting policy recommendations that would provide direction to resolving flooding problems. This Task Force includes a broad cross-section of citizens and officials from the City and meets regularly. The Task Force meetings involve the public in carrying out its mission. In addition, the initial 1999 report of the City's Citywide Flood Task Force was prepared, and the policy recommendations it contains, were prepared with the active and sustained input of City officials, including the Mayor and five members of the City Common Council, as well as nine members of the general public. City staff involved in the prepa-

Table 12

COMPARISON OF 100-YEAR RECURRENCE INTERVAL FLOOD FLOWS FOR UNDERWOOD CREEK

Location	River Mile	Planned Land Use and Existing Channel Conditions (cfs)[a]	Planned Land Use and Recommended Channel Conditions (cfs)[a]	Federal Flood Insurance Study (cfs)
At Canadian Pacific Railway	7.68	74	74	165[b]
Above Confluence with Dousman Ditch	7.08	158	158	165[b]
At Canadian Pacific Railway	6.32	727	715	1,175[b]
At Santa Maria Drive	5.85	847	831	1,430[b]
About 930 Feet Downstream of Clearwater Drive	5.41	847	831	1,680[b]
At North Avenue	4.82	1,040	1,020	1,540[b]
At Juneau Boulevard	3.67	1,170	1,170	1,950[c]
Above Confluence with the South Branch of Underwood Creek	2.56	1,550	1,120[d]	1,950[c]
Just Downstream of Confluence with the South Branch of Underwood Creek	2.50	3,460	3,470	--
About 90 Feet Upstream of W. Watertown Plank Road	1.53	4,410	4,390	5,400[e]
Just Upstream of USH 45	0.76	5,190	5,170	5,400[e]
Above Confluence with the Menomonee River	0.06	6,040	6,010	5,400[e]

[a] *Based on simulated record from 1940 through 1997.*

[b] *Flow based on 1986 Federal Emergency Management Agency (FEMA) Federal Flood Insurance Study for the City of Brookfield.*

[c] *Flow based on 1982 FEMA Federal Flood Insurance Study for the Village of Elm Grove.*

[d] *Flow in existing stream only. 550 cfs would be conveyed in the concrete box diversion.*

[e] *Flow based on 1978 FEMA Federal Flood Insurance Study for the City of Wauwatosa.*

Source: SEWRPC.

Table 13

COMPARISON OF 100-YEAR RECURRENCE INTERVAL FLOOD FLOWS FOR DOUSMAN DITCH

Location	River Mile	Planned Land Use and Existing Channel Conditions (cfs)[a]	Planned Land Use and Recommended Channel Conditions (cfs)[a]	1986 Federal Flood Insurance Study for the City of Brookfield (cfs)
About 1,080 Feet Upstream of Private Drive Entrance to Dunkel Inn	1.48	452	384	715
At Private Drive Entrance to Dunkel Inn	1.26	356	334	715
About 490 Feet Upstream of Gebhardt Road	0.72	356	334	900
Above Confluence with Underwood Creek	0.02	543	528	900

[a] *Based on simulated record from 1940 through 1997.*

Source: SEWRPC.

ration of the report included the City's Director of Administrative Services and Disaster Mitigation, the Interim City Engineer and other members of the City's engineering staff, the Manager of the City's sewage treatment plant, and the City Clerk. Consultation with other agencies and consultants in the preparation of the Task Force report included members of the staffs of the WDNR and SEWRPC, as well as a member of the private engineering and land surveying firm Ruekert & Mielke, Inc.

Public Education Activities

The second subelement involves preparation and distribution of educational and self-help materials and City staff provision of educational programs. With regard to this subelement of the flood mitigation plan, the City staff has prepared and distributed various public informational and educational materials, including materials oriented toward local homeowners and designed to help them consider and potentially undertake actions to mitigate damage caused by stormwater flooding and sanitary sewer backups in the City. The City's Citywide Flood Task Force determined that citizens, with the proper knowledge, could minimize some of their own problems and prevent damage caused by stormwater and sanitary sewer backups. The Task Force thus strongly recommended that the City educate its residents regarding these matters, using all methods available, including, but not limited to, cable television, pamphlet development, individual seminars, the World Wide Web, and community speaking engagements. The Task Force has developed a list of the subjects to be incorporated into the City educational efforts, including the citywide stormwater management plan; proper filling and grading, including landscaping and diversion of downspout water; WDNR well regulations; the ramifications of clear-water introduction into the sanitary sewer system; and methods of reducing flood damage to individual residences, including backflow valves, backup sump pumps, emergency standby generators, and hung sewers.

Existing educational materials produced as a part of this effort include a self-help guide for local property owners (see Appendix B). The guide sets forth potential causes of basement flooding, potential preventive measures that may be taken by homeowners, and information regarding potential actions that homeowners might take after flood damage occurs to a residence. Other, related materials have been prepared and distributed as part of the City's informational and educational efforts. These informational and educational activities are part of the City's efforts toward resolving the flooding and related stormwater drainage and sanitary sewer backup problems in the City.

Public Participation Activities and Coordination with Other Agencies and Units of Government

The third subelement of this program involves direct public participation and coordination with other agencies during subwatershed area detailed stormwater and floodland management plan development. As previously noted, the City engages in ongoing stormwater and floodland management programs through the activities of its Citywide Flood Task Force and of the City of Brookfield-Village of Elm Grove Underwood Creek Flooding Task Force. Both of these task forces were formed in 1998 following the major flood event in August of that year. As noted in Chapter III of this report, the City Common Council authorized the creation of the Citywide Flood Task Force to research problems, identify needs, and present policy recommendations that would provide direction to present and future stormwater planning initiatives for the City. The Task Force issued a draft initial report and recommendations in 1999. The Underwood Creek Task Force, designed to be a cooperative effort between the City of Brookfield and the Village of Elm Grove, has, with the City of Brookfield Citywide Flood Task Force, played a key role in the preparation of the aforementioned comprehensive stormwater and floodland management plan for the Underwood Creek and Dousman Ditch subwatersheds in the City and the Village. This plan was prepared by SEWRPC and the private engineering and land surveying firm Ruekert & Mielke, Inc., in cooperation with the City, the Village, and the WDNR. In their preparation of the plan, including specific mitigation and other actions, these five parties had numerous opportunities to obtain public comments regarding problems that were experienced and to provide to the public information developed under the planning effort regarding solutions to flooding and stormwater management problems in the City and the Village. The main forums through which information was obtained from the public and the plan was discussed during its development were the regular meetings of the two task forces. Presentations were also made at several informational meetings for City and Village officials and the public. Between April 28, 1997, and November 29, 1999, inclusive, 20 public meetings regarding the plan were held.

Toward further informing the public regarding flood mitigation, stormwater and floodland management,

and related issues, the City of Brookfield and other concerned units and agencies of government will continue to involve members of the general public and to seek public input in the preparation and implementation of detailed local- and/or subwatershed-level recommendations, as well as in efforts to update or revise regional-, watershed-, or otherwise broader-level plans , regarding such issues. In this regard, the City of Brookfield will also continue its participation as a stakeholder in the Milwaukee Metropolitan Sewerage District's (MMSD) continuing watercourse management planning.

Secondary Plan Element

In addition to the above recommended measures, several secondary measures are recommended to be implemented. These secondary measures are described below.

National Flood Insurance Program and Floodplain and Floodplain Map Updating Efforts

The City of Brookfield has been designated by the Federal Emergency Management Agency (FEMA) as having flood hazard areas and has taken the steps needed to make its residents eligible to participate in the National Flood Insurance Program (NFIP). An initial FEMA Flood Insurance Study (FIS) has been completed by FEMA for the City. The City will continue to participate in the NFIP and will worth with FEMA to revise, as necessary, local flood insurance studies to reflect new flood hazard data. This effort will support and guide owners of property in floodprone areas within the City to purchase flood insurance in order to provide some financial relief for losses sustained in floods that may occur before the full implementation of the appropriate flood control measures identified in this mitigation plan.

As detailed in Chapter II of this report, the floodplains in the City are currently delineated and mapped as documented in a FEMA FIS dated August 1986. In 1998, the City, working cooperatively with Waukesha County, prepared up-to-date large-scale digital topographic mapping for the entire City. The City has also contracted with SEWRPC to update all of the hydrologic-hydraulic analyses for the floodplain areas in the City. The findings and results of this updating effort will be provided to FEMA with the object of initiating a cooperative effort to update the FIS study and mapping.

Lending Institution and Real-Estate-Agent Policies

It is expected that lending institutions will continue their practice of determining the floodprone status of properties before mortgage transactions and that the principal sources of flood hazard information be the most recent available studies for the watersheds and subwatersheds located partly or wholly within the City. It is further expected that real-estate brokers and salespersons continue to inform potential purchasers of property of any flood hazard that may exist as the site being traded in accord with rules of the Wisconsin Department of Regulation and Licensing, Bureau of Direct Licensing and Real Estate. In addition, the City of Brookfield will continue its administration of the National Flood Insurance Program by requiring submission of formal flood insurance letter of map amendment prior to development on lands identified in the floodplain on the Flood Insurance Study mapping.

Community Utility Policies and Emergency Programs

The City intends to work with other governmental units and agencies responsible for the design, construction, operation, and maintenance of public utilities and facilities, such as water supply and sewerage facilities, drainageways, and streets and highways, carry out those functions in a manner fully consistent with the land use and floodland mitigation measures set forth or noted in this plan. The City of Brookfield and Waukesha County will continue to implement existing emergency procedures and develop appropriate new emergency procedures as needed to provide residents of the City with timely information about floods and to help them in taking appropriate action.

Stream Channel Maintenance

The City will continue its regular stream channel maintenance program. This program would include the periodic removal of sediment deposits, heavy vegetation, and debris from all watercourses within the City, including bridge openings and culverts.

Stormwater Management Facilities Maintenance

The effectiveness of stormwater management conveyance and detention facilities can be sustained only if proper operation, repair, and maintenance procedures are carefully followed. Important maintenance procedures include the periodic repair of storm sewers, clearing of sewer obstructions, maintenance of open

vegetation channel linings, clearing of debris and sediment from open channels, maintenance of detention facility inlets and outlets, maintenance of detention basin vegetative cover, and periodic removal of sediment accumulated in detention basins. Thus, these maintenance activities will be carried out on a continuing basis to maximize the effectiveness of the stormwater management facilities and measures and to protect the capital investment in the facilities.

Survey of Buildings in and near the 100-Year Floodplain

In the preparation of the detailed recommendations for the Dousman Ditch and Underwood Creek subwatershed areas within the City of Brookfield and the Village of Elm Grove described above, large-scale topographic maps compiled in 1986 and 1998 were used. Those maps are valuable resources for the preparation of hydrologic and hydraulic models and the delineation of floodplain boundaries. However, the building grade elevations determined from those maps are only approximate. Thus, that subwatershed plan recommends that the City and the Village survey the low-grade elevations adjacent to buildings and the first-floor elevations of buildings in and near the 100-year floodplain of Underwood Creek and Dousman Ditch prior to proceeding with implementation of the recommended actions. This same recommendation applies to the remaining portions of the City for which detailed plans are underway.

PROBLEM RESOLUTION FOR REPETITIVE-LOSS STRUCTURES AND OTHER STRUCTURES

As reported in Chapter IV of this report, there are five single-family residences and one commercial building categorized by the Federal Emergency Management Agency as repetitive-loss structures. Five of these structures are located in the Dousman Ditch-Underwood Creek subwatersheds. One of these structures (number 10R on Map 9 and Appendix D) has been purchased and razed under the FEMA Hazard Mitigation Program administered by the Wisconsin Department of Military Affairs, Division of Emergency Management. A second structure (12R) is planned to be purchased and razed by the City. Funding has been requested under the same FEMA program noted above for this removal project. The area around a third structure (9R) has been filled, which is expected to resolve the problem, along with a lowered floodplain due to planned detention storage would be expected to eliminate any overland flooding. Two of the remaining three structures (13R and 14R) are located outside the identified flood hazard area based upon the revised flood stages developed under the detailed analyses for Dousman Ditch and Underwood Creek under current conditions. These flood stages are expected to be reduced somewhat as a result of the proposed detention. Thus, the only potential remaining problem would be sanitary sewer backup. The City is currently evaluating measures to resolve this problem citywide. The final repetitive-loss structure (11R) is located in the Fox River watershed and is not within the identified flood hazard area. Thus, the problems are expected to be related to local drainage or sanitary sewer backup. Drainage problems will be evaluated and solutions developed under the ongoing stormwater management actions being proposed by the City for the Fox River areas. Sanitary sewer backup problems are currently being evaluated and solutions being developed on a citywide basis.

In addition to the six repetitive-loss structures, there are 21 other structures identified with potential flood-related problems. Of these 21, 12 are in the Underwood Creek and Dousman Ditch subwatersheds. Of these 12, five (4, 5, 6, 7, and 17) are recommended to be acquired and removed under the plan and four structures (1, 2, 3, and 8) are recommended to be floodproofed or acquired and removed. The City has applied for funding to acquire and remove five of these structures. The remaining three (15, 16, and 26) are all located beyond the flood hazard area based upon the updated and revised flood stages developed under the detailed analyses developed for the Dousman Ditch and Underwood Creek subwatersheds. Thus, no direct overland flooding is expected. These structures are not known to experience problems, but were located on the edge of the FIS flood hazard area.

Of the nine structures with potential flooding problems in the Fox River watershed, seven (19, 20, 21, 22, 23, 24, and 25) are located beyond the floodplain, but are identified based upon an administrative agreement between the City and FEMA. These buildings are constructed on fill which has a surface elevation above the floodplain, but basement floors below the floodplain. No significant problems are known.

The remaining two structures (18 and 27) in the Fox River flood hazard area are commercial and industrial structures which are flooded to a shallow depth of less than 0.5 foot. The flooding solution would likely be

floodproofing. The ongoing stormwater management and floodland plan for the Fox River watershed portion of the City will identify the solution for these two structures.

For all structures a detailed field survey of each structure will need to be completed to verify the planned solutions noted above. Furthermore, once such surveys are completed, a supplementary evaluation of each structure will be carried out to determine if additional mitigative measures are needed.

COST-EFFECTIVENESS CONSIDERATIONS

The cost-effectiveness of the options for each structure in the Dousman Ditch and Underwood Creek subwatersheds was determined by detailed systems-level analyses for the entire subwatershed area. Similarly, the ongoing subwatershed analyses for the remaining portions of the City will develop detailed cost-effectiveness analyses considering the appropriate alternatives in those areas. The cost-effectiveness and practicality for each project component will be refined under the plan implementation activities. As noted previously, there are a number of structures recommended to be either floodproofed or purchased and removed in the Underwood Creek subwatershed. The final decision on those structures will be made based upon field survey and other considerations. Those considerations include evaluation of multiple-purpose benefits, as several structures are to be removed, both for damage reduction and for detention basin area development.

For all projects involving potential FEMA funding, the City will consult with the Wisconsin Department of Military Affairs, Division of Emergency Management, and FEMA as early in the grant application phase as practical to refine any needed cost-effective data. In this regard, it is recognized that certain project components, such as floodproofing, may not be eligible for FEMA funding. However, the analyses used to develop the selected and best alternative have not been constrained by Federal funding criteria. Rather, the plans have identified the best alternatives regardless of funding sources. However, as noted above, each project component will be reexamined and refined as implementation proceeds.

PLAN IMPLEMENTATION STRATEGIES

The recommended flood mitigation plan described in this report is designed to attain, to the maximum extent practicable, the goals and objectives set forth in Chapter III of this report. In a practical sense, however, the plan is not complete until the steps to implement it—that is, to convert the plan into action policies and programs—have been specified. Following formal adoption of the plan by the City of Brookfield, realization of the plan will require a long-term commitment to the objectives of the plan and a high degree of coordination and cooperation among City officials and staff and various City departments and other bodies, including the Citywide Flood Task Force; the joint City of Brookfield-Village of Elm Grove Underwood Creek Task Force; intergovernmental task forces or other committees that may be created in the future to help address common flood mitigation issues; other concerned units and agencies of government and their respective officials and staffs, area developers and lending institutions, and concerned private citizens in undertaking the substantial investments and series of actions needed to implement the plan. Other units and agencies concerned in plan implementation include, but are not limited to, the Village of Elm Grove and other municipalities located partly or wholly within the watershed areas that lie partly within the City of Brookfield; the Waukesha County Office of Emergency Management; the MMSD; SEWRPC; the WDNR; the Wisconsin Department of Military Affairs, Division of Emergency Management; and FEMA.

A summary of the plan elements and selected implementation strategy information, including costs, designated management agencies, and schedules is included in Table 14. An important first step in implementation of the flood mitigation plan for the City of Brookfield is its formal adoption by the City Plan Commission and the City Council. Upon its formal adoption by the City, the plan becomes an important guide to the making of flood mitigation and floodland management decisions for the City by City officials. Such adoption serves to signify agreement with and official support of the plan recommendations and enables City officials and staff to begin integrating the plan recommendations into the City's ongoing land use control, and public works development planning and programming.

Table 14

CITY OF BROOKFIELD FLOOD MITIGATION PLAN SUMMARY AND IMPLEMENTATION STRATEGIES

Plan Element and Plan Adoption	Subelement and Plan Implementation Strategies	Estimated Cost		Designated Management Agency	Implementation Status Notes	Plan Implementation Schedule
		Capital	Average Annual Operation and Maintenance			
Environmentally Sensitive Land Preservation	Continue to implement floodplain zoning and wetland preservation zoning	--[a]	--[a]	City of Brookfield and Waukesha County	Plan implementation largely complete in City of Brookfield. Wetland areas are under County or City ownership	In place and ongoing
	Continue to implement environmentally sensitive land and open space preservation and acquisition policies	--[a]	--[a]	City of Brookfield and Waukesha County	Plan implementation largely complete. Environmentally sensitive lands are largely protected	In place and ongoing
Stormwater Management	Continue implementation of stormwater-related regulation and policies	--[a]	--[a]	City of Brookfield	Currently being implemented. New requirements expected in 2002 and beyond based upon MMSD rules and WDNR permit requirements	Ongoing
	Implementation of City stormwater management plans and guides					
	Citywide stormwater management guide	--[b]	--[b]	City of Brookfield	Major component is stormwater management planning by subwatershed	Ongoing
	124th and Congress area	$3.3 million[c]	$150,000[c]	City of Brookfield in cooperation with the City of Wauwatosa, Village of Lannon, and Union Pacific Railroad	Implementation underway	Implementation by 2003
	Dousman Ditch and Underwood Creek subwatersheds	$9.5 million	$28,000	City of Brookfield and Village of Elm Grove in cooperation with WDNR, MMSD, and private sector	Underway with plan refinement and project implementation	See prioritization schedule in subsequent section of plan
	Fox River and Butler Ditch subwatershed portions of City	--[b]	--[b]	City of Brookfield in cooperation with Village of Menomonee Falls and WDNR	Underway. Plans will develop appropriate and cost-effective mitigation measures considering acquisition, floodproofing, and other options	Plan in place by 2002
Floodland Management	Continue with second-level system plans to refine preliminary recommended plan and then implement plan					
	Dousman Ditch and Underwood Creek subwatersheds	$14.5-$22.3 million[d]	$36,000[d]	City of Brookfield and Village of Elm Grove in cooperation with watershed stakeholders	Implementation underway with second-level planning and acquisition and removal of structures being partially completed	Partially implemented. Construction of projects based upon second-level planning
	Fox River and Butler Ditch subwatershed portions of City	--[b]	--[b]	City of Brookfield, and Village of Menomonee Falls	Plan preparation is underway. One structure is removed from flood hazard area	Schedule to be developed as part of plan
Public Information and Education	Continued citywide public involvement	--[a]	--[a]	City of Brookfield	--	Ongoing
	Public education activities	--	$2,000	City of Brookfield	--	2002-2003

Table 14 (continued)

Plan Element and Plan Adoption	Subelement and Plan Implementation Strategies	Estimated Cost		Designated Management Agency	Implementation Status Notes	Plan Implementation Schedule
		Capital	Average Annual Operation and Maintenance			
Public Information and Education (continued)	Public involvement and coordination with other agencies and local units of government	--[a]	--[a]	City of Brookfield in cooperation with other watershed stakeholders	In progress	Ongoing
Secondary Plan Element	National flood insurance program and floodplain mapping efforts	--[a]	--[a]	City of Brookfield in conjunction with WDNR, FEMA, and SEWRPC	Being implemented	Ongoing
	Lending institution and real-estate policies	--[a]	--[a]	City of Brookfield, real-estate brokers, and lending institutions	Being implemented	Ongoing
	Community utility policies and emergency programs	--[a]	--[a]	City of Brookfield and Waukesha County Department of Emergency Management	Being implemented	Ongoing
	Stream channel maintenance	--[a]	--[a]	City of Brookfield	Being implemented	Ongoing
	Stormwater and floodland management facilities maintenance	--[e]	--[e]	City of Brookfield	Being implemented	Ongoing
Plan Adoption	--	--	--	City of Brookfield Council upon recommendation by appropriate City committee(s)	Following draft plan review	During 2001
Plan Monitoring	Review, evaluate, and refine mitigation plan annually	--[a]	--[a]	City of Brookfield Council and Departments of Administration, Development, and Public Works; and City Task Force	--	End 2002 and then annually with special review following each major flood event
Emergency Operations Coordination, Plan Refinement, and Post-Disaster Review	Review, evaluate, and refine plan following flood events in cooperation with emergency operations program	--[a]	--[a]	City of Brookfield and Waukesha County Department of Emergency Management	--	Annually, with special review following each major flood event

NOTE: Where City of Brookfield is noted as the designated management agency, it is intended to be the City Department of Administration in cooperation with other departments, with policy review and guidance by the City Council.

[a] *No new cost involved. Costs are assigned to other ongoing City programs.*

[b] *Details on funding needs will be developed as part of stormwater and floodland management plans being developed.*

[c] *Based upon costs set forth in April 1995 report by Woodward-Clyde,* Stormwater Management Plan for the West Side of the Lower Menomonee River Subwatershed, *increased by 1 percent to reflect changes in construction cost from 1995 to 2000.*

[d] *Costs currently being refined as part of second-level planning and preliminary design.*

[e] *New costs included under stormwater management and floodland management elements operation and maintenance.*

Source: City of Brookfield, Ruekert & Mielke, Inc., and SEWRPC.

A preliminary prioritization of the Dousman Ditch and Underwood Creek subwatershed-level capital improvements is set forth in Table 15. For this prioritization, a project is defined as a set of stormwater or floodland management components that should be constructed in concert in order for the set to function properly by itself and within the context of the larger system of which it is a part.

The projects are classified as high-, medium-, or low-priority projects. The high-priority projects are those that address the most significant existing problems, including direct flooding of structures. The medium-priority projects are predominantly those 1) that are required to upgrade the minor system to meet the plan standards and 2) that are of somewhat greater extent than the low-priority projects, but do not relate to the prevention of direct flooding of buildings. The low-priority projects are those that are required to upgrade the minor system to meet the plan standards and to address localized problems.

The sequence in which projects are actually implemented and the time at which they are implemented will ultimately depend on a number of factors not related solely to stormwater and floodland management considerations. Such factors include budgetary constraints, the need to implement other projects in the City and Village capital improvements programs, and variations in future development and redevelopment patterns as determined by the urban land market.

In general, projects that call for upgrading the existing stormwater conveyance system should proceed from downstream to upstream to ensure that the downstream portions of the system are not overloaded when the hydraulic capacities of the upstream portions are increased. The recommended sequence for constructing the subwatershed-level water quality and floodland management plan elements is described below.

Projects Nos. 1, 2a, and 2b in Table 15—described in the table as, respectively, 1) dual-purpose wet detention basin along Dousman Ditch and 2) Underwood Creek overflow channel and diversion, compensating storage, and structure floodproofing or removal—should be coordinated. The three floodwater storage components—along Dousman Ditch, upstream of W. North Avenue, and in the Village Park—should be constructed first. If they are to be constructed individually at different times, the best sequence would involve proceeding from upstream to downstream. After completing construction of the storage areas, the overflow channel should be constructed, followed by the diversion culvert. The construction sequence set forth herein would ensure that downstream flood flows and stages would not be increased during any phases of the project.

PLAN MONITORING STRATEGIES

For a flood mitigation plan to be successful, it must not only be implemented; it must be monitored. Plan monitoring is best accomplished through a formal, periodic process designed to measure and assess progress in implementation, changing outside circumstances that may affect the plan and efforts to implement it, and the need for any changes to the plan and/or to how it is being implemented. In addition, the plan should be reviewed following each flood event occurrence to assess its continued viability and the need for revisions.

Toward ensuring successful monitoring of the flood mitigation plan for the City of Brookfield, the City intends that the Citywide Flood Task Force meet at least annually to review the plan and the status of its implementation, as well as to develop and recommend any necessary revisions to the plan to the City Plan Commission and City Common Council for consideration and possible adoption by those bodies. It is recommended that revisions be proposed, considered, and adopted in the form of formal amendment to the mitigation plan. This review process will be coordinated and conducted by the City Department of Administration with input from, coordination with, and participation by all concerned City officials and staff, all units and agencies of government involved in plan implementation, and concerned private parties, including residents of the City.

The Citywide Flood Task Force, in its review process, will periodically examine the plan and the efforts to implement it with respect to 1) whether any flood hazards affecting the City have changed, and, if so, how they have changed; 2) whether any flood mitigation goals and objectives have changed, or need to be changed; 3) the degree and extent of progress made in implementing previously identified flood mitigation actions; 4) whether the plan recommendations and their priorities should remain unchanged or need modification; 5) whether any new recommendations are needed; and 6) whether applicable funding

Table 15

PRIORITIZATION OF RECOMMENDED SUBWATERSHED-LEVEL PROJECTS FOR THE DOUSMAN DITCH AND UNDERWOOD CREEK SUBWATERSHEDS IN THE CITY OF BROOKFIELD AND THE VILLAGE OF ELM GROVE

Project Designation	Location of Component	Hydrologic Unit (H.U.)	Plan Components As Listed In Table 9	Capital Cost[a]
High-Priority Projects[a]				
Floodland Management/Water Quality Management				
1. Dual-Purpose Wet Detention Basin Along Dousman Ditch	City of Brookfield	DD-7	Water quality plan element Items 1 through 4. Floodland management plan element Item 2	$ 4,350,000[b]
2a. Compensating Storage, and Structure Floodproofing or Removal	City of Brookfield	--	Floodland management plan element Items 9, 10, 11, 13, and 15	1,603,000
2b. Underwood Creek Overflow Channel, Compensating Storage, and Structure Floodproofing or Removal	Village of Elm Grove	DD-7	Floodland management plan element Items 3 through 8 and 11 through 14	12,772,000
Stormwater Drainage/Water Quality Management				
3. Verdant Drive	Village of Elm Grove	DD-5	H.U. DD-5 Items 1 through 4	$ 305,000
4. Victoria Circle North	Village of Elm Grove	DD-8	H.U. DD-8 Victoria Circle North Items 1 through 3	170,000
5. Wrayburn Road	Village of Elm Grove	UC-8	H.U. UC-8 Items 1 through 8	231,000
6. Elmhurst Parkway	Village of Elm Grove	UC-9	H.U. UC-9 Items 1 through 5	409,000
7. Briaridge Court/Squires Grove	Village of Elm Grove	DD-7	H.U. DD-7 Items 1 and 2	106,000
8. Bishops Woods Tributary	Village of Elm Grove	UC-10	H.U. UC-10 Item 1	45,000
9. Grandview/Kurtis	Village of Elm Grove	UC-11	H.U. UC-11 Items 1 through 3	119,000
10. Downtown Street Sweeping	Village of Elm Grove	UC-11	Water quality plan element Item 5	1,000
11. Indianwood/Onondaga	City of Brookfield	DD-8	H.U. DD-8 Indianwood/Onondaga Items 1 through 3	355,000
12. Tru/Adelaide	City of Brookfield	UC-7	H.U. UC-7 Items 1 through 14	2,565,000
13. San Juan Trail	City of Brookfield	UC-6	H.U. UC-6 Items 1 through 7	234,000
14. Pomona Road	City of Brookfield	UC-4	H.U. UC-4 Items 1 and 2	79,000
15. Clearwater Drive	City of Brookfield	UC-4	Four replacement culverts, road grade raise, compensating storage	120,000
16. Westwood Drive	City of Brookfield	UC-5	H.U. UC-5 Items 1 through 5	108,000
17. Street Sweeping	City of Brookfield	UC-10	Water quality plan element Item 5	5,000
Medium-Priority Projects				
1. San Fernando Drive	Village of Elm Grove	UC-8	H.U. UC-8 Items 9 through 12	$ 165,000
2. N. 124th Street	Village of Elm Grove	UC-13	H.U. UC-13 Items 1 and 2	19,000
3. Centa Lane	Village of Elm Grove	UC-14	H.U. UC-14 Items 1 through 3	33,000
4. Mt. Vernon Avenue	City of Brookfield	DD-7	H.U. DD-5 Item 5	2,000
5. Gebhardt Road	City of Brookfield	DD-9	H.U. DD-9 Items 1 and 2	128,000
6. Brookfield East High School	City of Brookfield	UC-6	H.U. UC-6 Items 8 through 13	206,000

Table 15 (continued)

Project Designation	Location of Component	Hydrologic Unit (H.U.)	Plan Components As Listed In Table 9	Capital Cost[a]
Low-Priority Projects				
Stormwater Drainage				
1. Pilgrim Parkway	Village of Elm Grove	DD-9	H.U. DD-9 Item 3	$ 4,000
2. Patricia Lane/Lucy Circle	City of Brookfield	DD-2	H.U. DD-2 Items 1 and 2	14,000
3. Burleigh Boulevard/Luella Drive	City of Brookfield	UC-1	H.U. UC-1 Items 1 through 5	76,000
4. Hillside Drive	City of Brookfield	UC-2	H.U. UC-2 Item 1	4,000
5. N. 131st Street	City of Brookfield	UC-7 and 8	H.U. UC-8 Item 13	11,000
Total	--	--	--	$24,239,000[c]

[a]Includes 35 percent for engineering, administration, and contingencies. Costs are for year 1998 with Engineering News-Record Construction Cost Index = 6,740.

[b]A maximum of $2,828,000 in State of Wisconsin nonpoint source grant funds may be available for this wet detention basin. Of that amount, a total of $1,131,000 would be applied against the City of Brookfield share and $1,697,000 against the Village of Elm Grove share.

[c]This cost could be increased by up to $7,450,000 if it were necessary to purchase and remove all structures for which floodproofing is recommended.

Source: SEWRPC.

programs and levels have changed. As an integral part of its review process, the Task Force will submit an annual written report to the City Plan Commission and City Common Council setting forth the status of plan implementation efforts, detailing plan implementation actions taken over the past year, prioritizing mitigation goals and activities for the next year, and setting forth any recommended revisions to the plan. It is also recommended that the Task Force oversee the development and maintenance of a tracking and archiving system for all future detailed flood mitigation and stormwater management studies undertaken by and/or for the City. Such studies should be evaluated using policies established either by the Task Force or the City Common Council.

The plan monitoring and refinement strategy will include a post-disaster component whereby the plan is reviewed and evaluated after any future major flood event. Based upon this review, the mitigation plan will be updated or revised as needed based upon the flood event experiences, circumstances, and consequences. In this regard, the post-disaster review effort will be coordinated with the emergency operations program administered by the City and the Waukesha County Department of Emergency Government. The experiences of the emergency operations may indicate a need for refined mitigation actions which would then be incorporated into the plan. Information will also be collected from the WDNR, SEWRPC, and FEMA personnel. Any plan updating found to be needed will be incorporated into the annual plan update noted above.

The City Department of Administration be responsible on a day-to-day basis for creating and implementing a common monitoring system. This will require close cooperation and coordination with other units of government and agencies involved.

Reevaluation and Updating of Subwatershed-Level Recommendations

The components of the flood mitigation plan developed under subwatershed-level planning efforts should be reevaluated at approximately five-year intervals, considering the degree to which the actions recom-

mended under such efforts have been implemented and incorporating any changes in the available rainfall-duration-frequency data and in the state of the art of stormwater and floodland management. The plan components, including the need for certain facilities and the location, size, and capacity of facilities, should be revised as necessary to reflect changing conditions and stormwater management needs in accord with the plan review-revision procedures recommended above.

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APPENDICES

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Appendix A

EXCERPT FROM SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 108 REGARDING INTEGRATION OF WETLAND AND FLOODPLAIN PRESERVATION WITH PARK AND OPEN SPACE PLANNING

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Appendix A

WETLANDS PRESERVATION PLAN FOR THE CITY OF BROOKFIELD

INTRODUCTION

Wetlands and associated floodlands provide a variety of benefits, including stormwater management, flood control, and surface water drainage benefits; water quality protection and enhancement; fish and wildlife habitat; a setting for groundwater recharge and discharge; a setting for park and limited outdoor recreation use; and a setting for other open space uses, including contributing to the character and identity of an area and lending form and structure to urban development patterns.

Recognizing the importance of wetlands and associated undeveloped floodlands to the overall environmental health and quality of life within the City, the City of Brookfield Plan Commission on January 16, 1989, formed a Wetlands Management Task Force, which was to be responsible for the preparation of a wetlands preservation plan for the City. The Wetlands Management Task Force, on April 14, 1989, requested that the Regional Planning Commission, as part of the open space preservation element of the park and open space plan for the City of Brookfield, provide detailed inventory information on wetlands and floodlands in the Brookfield study area; identify those wetlands and floodlands necessary for park and related outdoor recreation uses; and prepare a wetlands preservation plan for the City. On November 8, 1989, the Task Force reviewed a preliminary draft of the desired wetlands preservation plan and recommended that the wetlands preservation plan as set forth herein be incorporated into the park and open space plan for the City.

The first section of this wetlands preservation plan presents inventory information on wetlands and floodlands in the Brookfield study area, including information on the location and extent of wetlands in the study area, ownership of wetlands, and the extent of wetlands under state and federal protective jurisdiction, as well as related information on the extent, ownership, and natural resource composition of floodlands. The second section sets forth the wetlands preservation plan, including recommendations for the preservation of wetlands within the primary environmental corridors, and for the preservation of other large (five acres or larger in size) wetlands.

EXISTING WETLANDS AND FLOODLANDS IN THE BROOKFIELD STUDY AREA

The preparation of a sound wetlands preservation plan for the City of Brookfield requires detailed information on the wetlands and related floodlands in the study area. This section presents such detailed information on the location, extent, and ownership of wetlands and on the location, extent, ownership and natural resource composition of related floodlands.

Wetlands

Wetlands are defined as those areas which are inundated or saturated by surface or groundwater at a frequency and with a duration sufficient to support, and that, under normal circumstances, do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.[1] In southeastern Wisconsin, including in the Brookfield study area, such areas include 11 basic wetland types: deep marshes, shallow marshes, southern sedge meadows, shrub carrs, alder thickets, fresh wet meadows, low prairies, fens, bogs, lowland hardwoods, and conifer swamps.

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[1] *33 Code of Federal Regulations, 1990 edition, 328.3(b).*

As already noted, wetlands are an important part of the landscape in that they perform an important set of natural functions that make them ecologically and environmentally invaluable resources. These functions are summarized below.

1. Wetlands affect the water quality. The aquatic plants which grow in wetlands change inorganic nutrients, such as phosphorus and nitrogen, into organic material, storing it in their leaves. In addition, the stems, leaves, and roots of these plants slow the flow of water through the wetlands, allowing silt and other sediments with the attached nutrients and water pollutants to settle, therefore protecting downstream resources from siltation and pollution.

2. Wetlands influence the quantity of water by acting to provide water during periods of drought and to hold back water during periods of wet weather, thereby stabilizing stream flows and controlling downstream flooding.

3. Wetlands which are located along rivers and streams help protect the shoreline from erosion.

4. Wetlands may serve as groundwater recharge and discharge areas.

5. Wetlands are important wildlife habitat areas. Wetlands provide essential breeding, nesting, resting, and feeding grounds, and provide escape cover for many forms of fish, bird, and other animal life.

Wetlands are important resources for overall ecological health and diversity. Wetlands have educational and research values; support certain commercial and recreational activities such as fishing; and add aesthetic value to an area. In addition, wetlands and adjacent upland areas may provide opportunities for certain outdoor recreation uses, such as trail-related use and other passive recreation use.

Wetlands also have severe limitations for residential, commercial, and industrial development. Generally, these limitations are due to the erosive character, high compressibility and instability, high water table, low bearing capacity, and high shrink-swell potential of wetlands soils. In addition, the use of metal conduits in some wetland soil types is constrained because of high corrosion potential. These limitations may result in flooding, wet basements and excessive operation of sump pumps, unstable foundations, failing pavements, broken sewer and water lines, and excessive infiltration of clear water into sanitary sewers. There are also significant onsite preparation and maintenance costs associated with development on wetland soils, particularly as they relate to roads, foundations, and public utilities.

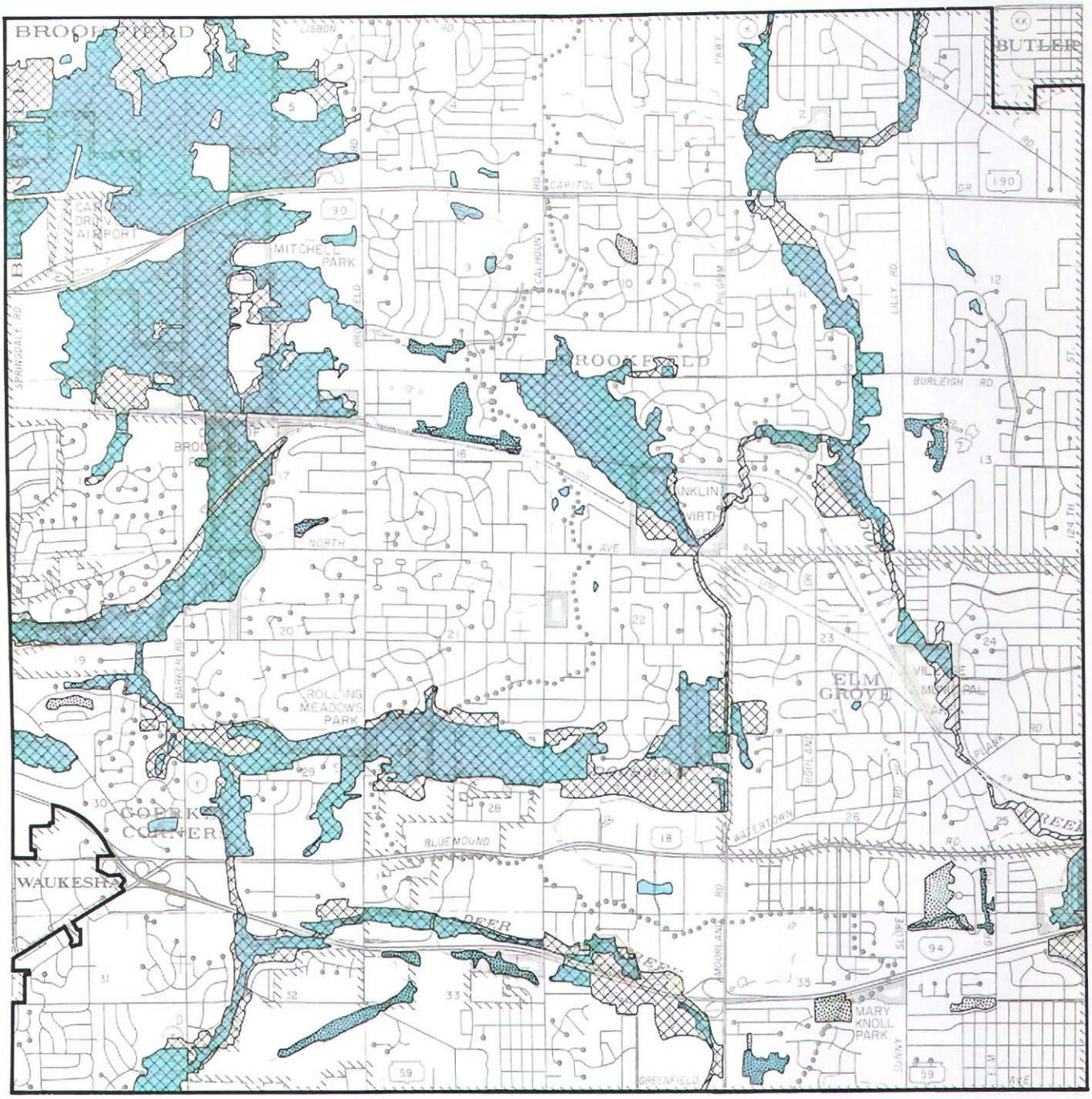
The location and extent of wetlands in the Brookfield study area are shown graphically on Map A-1, while the ownership of wetlands is summarized in Table A-1. As shown on Map A-1 and indicated on Table A-1, there were about 3,229 acres of wetlands in the Brookfield study area. Of this total, about 2,308 acres, or 71 percent, were located in the City of Brookfield. As indicated in Table A-1, of the total 3,229 acres of wetlands in the study area, about 874 acres, or 27 percent, were in existing public park and open space sites; including 811 acres in parks, 29 acres in public school sites, and 34 acres in other publicly-owned lands; and about 18 acres, or about 1 percent, were in nonpublicly-owned outdoor recreation sites. In total, then, about 892 acres, or 28 percent of the wetlands in the study area, were in existing public or private park and open space sites; while the remaining 2,337 acres, or 72 percent, were in other private ownership.

As further indicated in Table A-1, of the 2,308 acres of wetlands in the City of Brookfield, about 847 acres, or about 37 percent, were in existing park and open space sites, including 829 acres in publicly-owned sites, and 18 acres in privately-owned outdoor recreation and open space sites. The remaining 1,461 acres, or 63 percent of the wetlands in the City, were in other private ownership.

As indicated in Table 7 in Chapter II of this report, of the total 3,229 acres of wetlands in the Brookfield study area, about 3,040 acres, or about 94 percent, were located within the identified primary environmental corridors, while the remaining 189 acres, or about 6 percent, were located

Map A-1

WETLANDS IN THE BROOKFIELD STUDY AREA



Source: SEWRPC.

Table A-1

OWNERSHIP OF WETLANDS IN THE BROOKFIELD STUDY AREA: 1989

Civil Division	Existing Park and Open Space Sites									Subtotal		Other Nonpublic Ownership		Total	
	Public Ownership					Nonpublic Ownership									
	Park (acres)	School (acres)	Other (acres)	Subtotal (acres)	Percent of Total	Recreation Site (acres)	School (acres)	Subtotal (acres)	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent
City of Brookfield	772	23	34	829	25.7	18	--	18	0.5	847	26.2	1,461	45.3	2,308	71.5
Remainder of Study Area	39	6	--	45	1.4	--	--	--	--	45	1.4	876	27.1	921	28.5
Total	811	29	34	874	27.1	18	--	18	0.5	892	27.6	2,337	72.4	3,229	100.0

Source: City of Brookfield Department of Parks and Recreation and SEWRPC.

within secondary environmental corridors, isolated natural areas, or smaller isolated areas of less than five acres. Of the 2,308 acres of wetlands in the City of Brookfield, about 2,152 acres, or about 93 percent, were located in primary environmental corridors, while the remaining 156 acres, or about 7 percent, were in secondary environmental corridors, isolated natural areas, or were found in small, isolated pockets in the City.

The wetlands in the Brookfield study area which are regulated under Chapters NR115 or NR117 of the Wisconsin Administrative Code are shown on Map A-2. Under the Administrative Code, drainage, filling, or intensive uses of regulated wetlands is generally not permitted. As shown on Map A-2, of the 3,229 acres of wetlands in the Brookfield study area, about 2,707 acres, or about 84 percent, were regulated. In addition, the U. S. Army Corps of Engineers, under Section 404 of the federal Clean Water Act, also regulates filling, draining, or other intensive uses of wetlands. Of the 3,229 acres of wetlands in the study area, about 3,192 acres, or about 99 percent, were under such protective regulation by the U. S. Army Corps of Engineers.

Floodlands

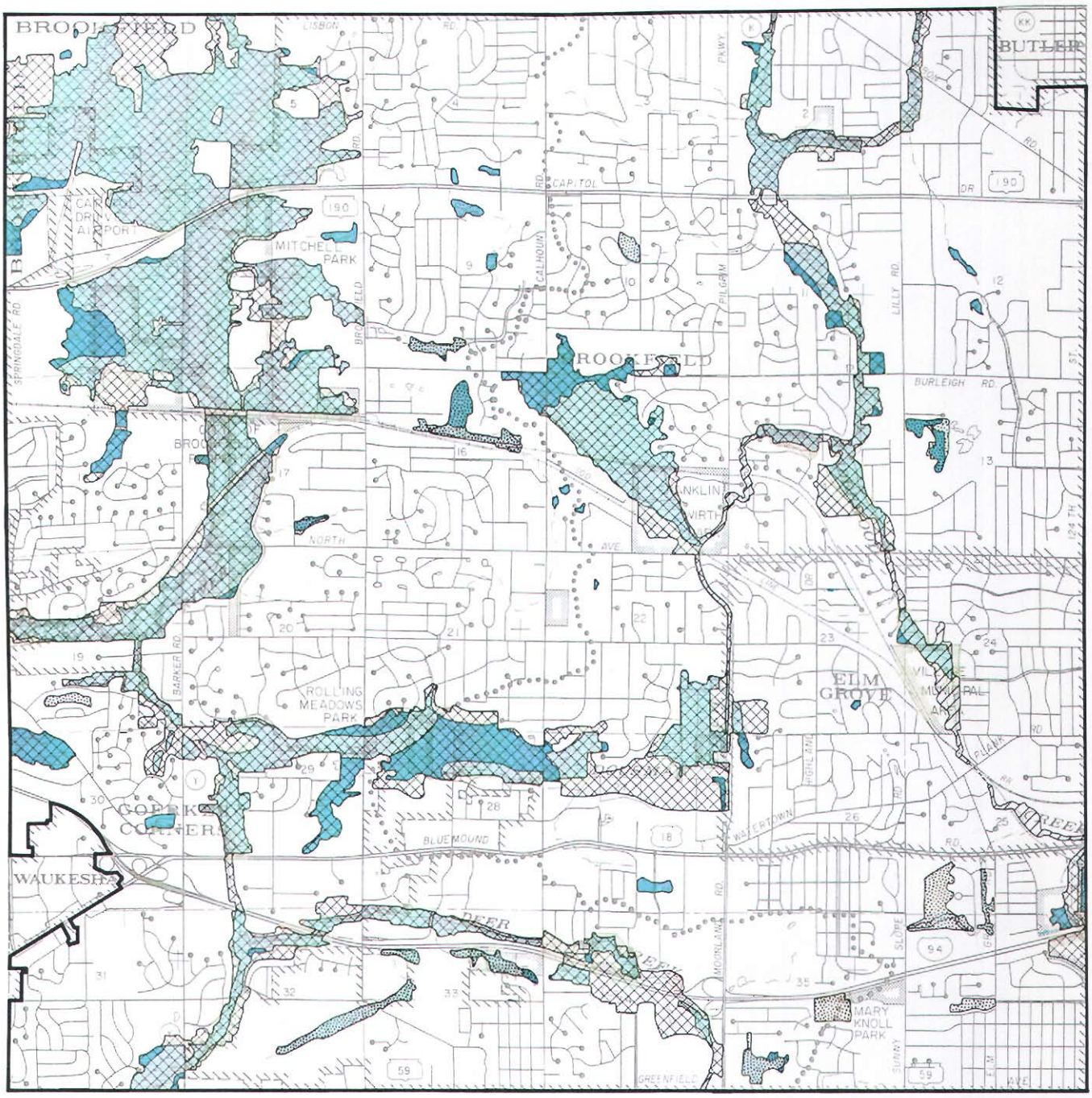
The floodlands of a river or stream generally consist of relatively wide, gently sloping areas contiguous to, and usually lying on both sides of, a river or stream channel. When stream discharges increase beyond the conveyance capacity of the channel, the river or stream rises and spreads laterally over the floodlands, causing a flooding event to occur. For planning and regulatory purposes, floodlands are normally defined as the areas, excluding the channels, subject to inundation by the 100-year recurrence interval flood event.

Floodland areas, like wetlands, are generally not well suited to urban development, not only because of flood hazards, but also because of seasonally or perennially high water tables and, generally, the presence of soils not well suited to urban development. However, the floodland areas often contain important elements of the natural resource base, such as wetlands and wildlife habitat areas, and therefore constitute important locations for open space lands, including park and parkway lands. Floodlands also provide storage for floodwaters and thereby decrease downstream flood discharges and stages. Every effort should be made to discourage incompatible intensive use of floodlands, while encouraging compatible natural open and parkway uses.

As already noted, the City of Brookfield Wetlands Management Task Force requested that detailed inventory information on floodlands be provided. Under the National Flood Insurance Act of 1968, the U. S. Department of Housing and Urban Development, Federal Emergency Management Agency, was given authority to conduct studies to determine the location and extent of floodlands. Map A-3 shows the distribution of floodlands, as prepared by the Federal Emergency Management Agency in 1986, for the Brookfield study area. The composition of floodlands is summarized in Table A-2 and the ownership of floodlands is shown on Map A-4 and summarized in Table A-3.

Map A-2

WETLANDS IN THE BROOKFIELD STUDY AREA REGULATED BY THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES UNDER CHAPTER NR115 AND NR117 OF THE WISCONSIN ADMINISTRATIVE CODE



LEGEND

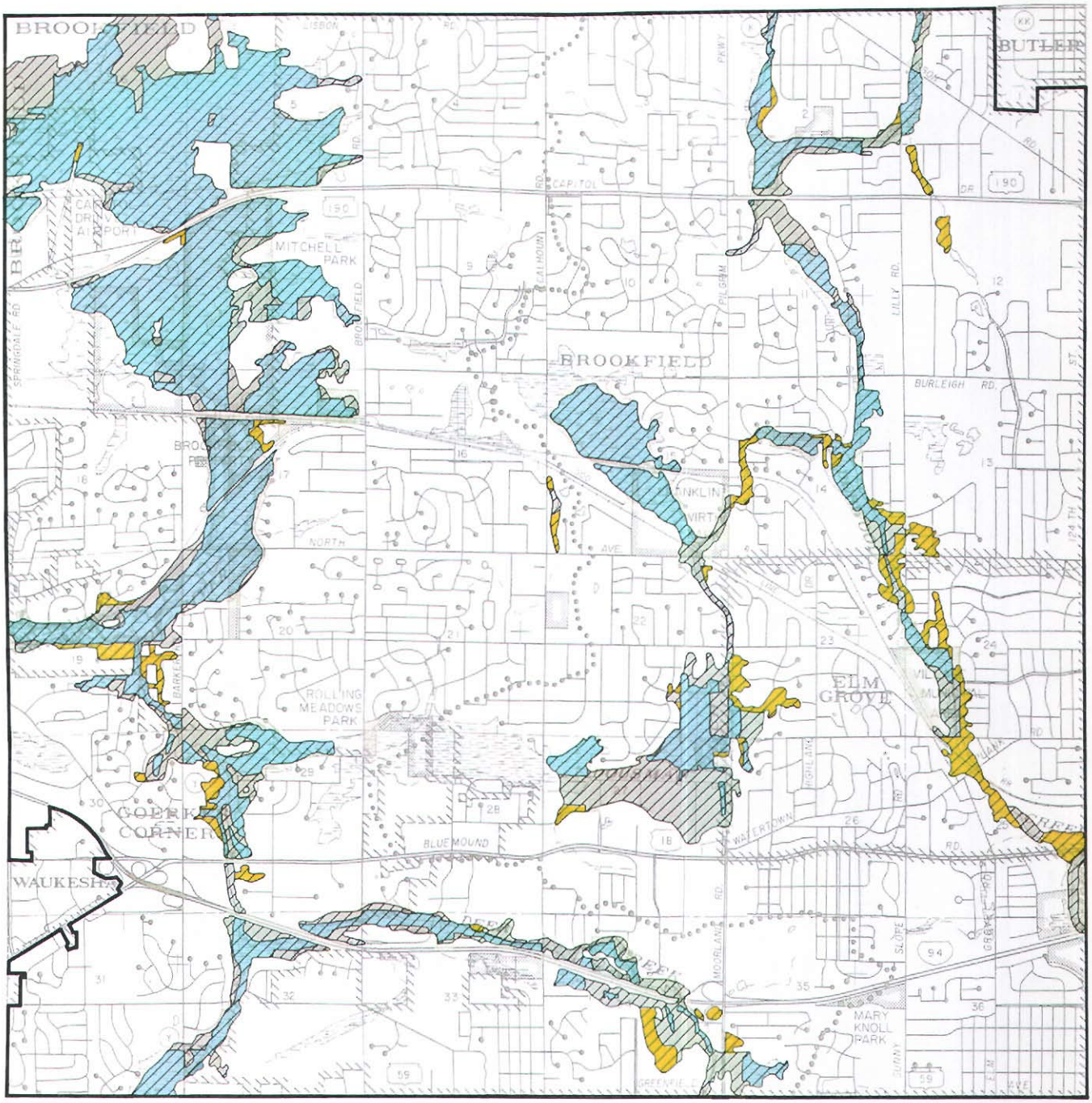
- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA
- WETLANDS REGULATED UNDER NR 115 OR NR 117
- WETLANDS NOT REGULATED UNDER NR 115 OR NR 117

GRAPHIC SCALE
0 1/4 1/2 1 MILE
0 2000 4000 FEET

Source: City of Brookfield and SEWRPC.

Map A-3

COMPOSITION OF FLOODLANDS IN THE BROOKFIELD STUDY AREA



Source: Federal Emergency Management Agency (FEMA) and SEWRPC.

Table A-2

COMPOSITION OF FLOODLANDS IN THE BROOKFIELD STUDY AREA: 1989

Civil Division	Composition of Floodlands						Total	
	Wetlands		Other Open Lands		Urban (developed)			
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
City of Brookfield	1,738	47.4	551	15.0	139	3.8	2,428	66.2
Remainder of Study Area	820	22.3	337	9.2	85	2.3	1,242	33.8
Total	2,558	69.7	888	24.2	224	6.1	3,670	100.0

Source: Federal Emergency Management Agency (FEMA) and SEWRPC.

As shown on Map A-3, floodlands were identified along the main rivers and streams in the Brookfield study area. As indicated in Table A-2, in 1989, there were about 3,670 acres of floodlands in the Brookfield study area. Of this total, about 2,428 acres, or about 66 percent, were in the City of Brookfield. As further indicated in Table A-2, of the total 3,670 acres of floodlands in the study area, about 2,558 acres, or about 70 percent, were also wetlands and about 888 acres, or about 24 percent, were other open lands. Developed urban uses encompassed the remaining 224 acres, or 6 percent, of the floodlands in the study area. As further indicated in Table A-2, floodlands in the City of Brookfield encompassed about 2,428 acres, or about 66 percent of the floodlands in the study area and about 14 percent of the total area of the City. Of these 2,428 acres, about 1,738 acres, or about 71 percent, were also wetlands and about 551 acres, or about 23 percent, were other open lands. Developed urban uses encompassed the remaining 139 acres, or 6 percent, of the floodlands in the City.

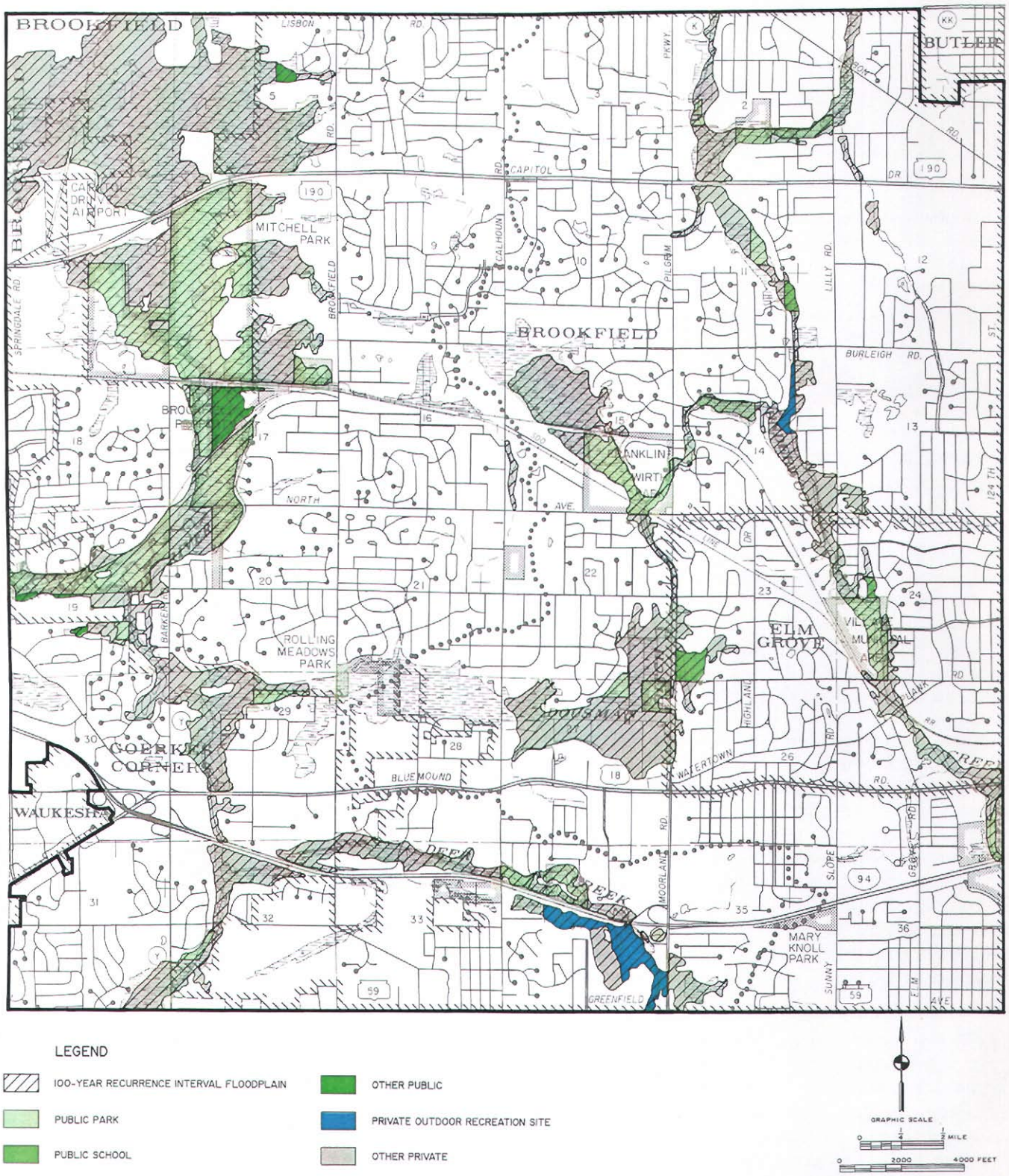
As shown on Map A-4 and indicated in Table A-3, of the total 3,670 acres of floodlands in the study area, about 703 acres, or about 19 percent, were in existing public park and open space sites, including 607 acres in parks, 41 acres in public school sites, and 55 acres in other publicly-owned lands; and about 80 acres, or about 2 percent, were in nonpublicly-owned outdoor recreation sites. In total, then, about 783 acres, or 21 percent of the floodlands in the study area, were in existing public or private park and open space sites; while the remaining 2,887 acres, or 79 percent, were in other private ownership. As further indicated in Table A-3, of the total 2,428 acres of floodlands in the City of Brookfield, about 688 acres, or about 28 percent, were in existing park and open space sites, including 608 acres in publicly-owned sites and 80 acres in nonpublicly-owned outdoor recreation and open space sites. The remaining 1,740 acres, or 72 percent of the floodlands in the City, were in other nonpublic ownership.

RECOMMENDED WETLANDS PRESERVATION PLAN

Under the park and open space plan for the City of Brookfield, it is recommended that certain wetlands, including associated floodlands, be acquired for limited outdoor recreation use, chiefly to provide a proper setting for the recreation trail system proposed in the plan. The plan recommends that the trail system be located at the edge of wetlands within the primary environmental corridor in the City. In addition, the plan recommends that certain other wetlands be acquired as part of the city system of multi-community, community, district, and neighborhood parks.

Map A-4

OWNERSHIP OF FLOODLANDS IN THE BROOKFIELD STUDY AREA



Source: City of Brookfield and SEWRPC.

Table A-3

OWNERSHIP OF FLOODLANDS IN THE BROOKFIELD STUDY AREA

Civil Division	Existing Park and Open Space Sites												Other Nonpublic Ownership		Total	
	Public Ownership					Nonpublic Ownership				Subtotal						
	Park (acres)	School (acres)	Other (acres)	Subtotal (acres)	Percent of Total	Recreation Site (acres)	School (acres)	Subtotal (acres)	Percent of Total	Acres	Percent of Total				Acres	Percent
City of Brookfield	538	15	55	608	16.6	80	--	80	2.2	688	18.8	1,740	47.4		2,428	66.2
Remainder of Study Area	69	26	--	95	2.5	--	--	--	--	95	2.5	1,147	31.3		1,242	33.8
Total	607	41	55	703	19.1	80	--	80	2.2	783	21.3	2,887	78.7		3,670	100.0

Source: Federal Emergency Management Agency (FEMA), City of Brookfield Department of Parks and Recreation, and SEWRPC.

Wetlands and associated floodlands, in addition to providing an appropriate setting for parks and trails, also provide a variety of other benefits and uses. These benefits and uses are most properly addressed within the context of a comprehensive land use plan for the City, as well as in detailed stormwater and floodwater management plans. Until such detailed plans can be prepared and the specific stormwater and floodwater management uses and water quality protection uses are identified, it is important to protect and preserve all significant wetlands in the City. The plan for the preservation of such wetlands is set forth in this section.

Under the wetlands preservation plan for the City of Brookfield, it is recommended that the City of Brookfield acquire the significant wetlands and associated floodlands in the City of Brookfield for a variety of stormwater management, water quality protection, and park and open space uses. The plan recommends that all wetlands within primary environmental corridors and all additional large (five acres or larger in size) wetlands be acquired. This recommendation is fully consistent with the recommendations set forth in the open space preservation element of the park and open space plan for the City of Brookfield. Implementation of the recommendations set forth under both the park and open space plan and under the wetlands preservation plan for the City would result in the acquisition and protection of all the important remaining wetlands in the City of Brookfield.

It is important to note that, while the usual manner of acquisition of land is the purchase of fee simple interest, there are methods of acquiring less than fee simple interest in the land. These other methods include the purchase and resale of land on condition; purchase and lease-back of land; acquisition of land subject to life estate; acquisition of tax delinquent land; acquisition of conservancy or scenic easements; acquisition through gift or donation; and acquisition through dedication. In addition, "clustered" residential development design options can also be used to preserve open space and to reserve lands for resource preservation and outdoor recreation purposes. Under the park and open space plan for the City, it is anticipated that lands proposed for park outdoor recreation use would be acquired through purchase of fee simple interest, but wetlands proposed for natural resource preservation purposes would be acquired generally through acquisition of tax delinquent land, acquisition through gift or donation, or acquisition through dedication.

It is also important to note that acquisition of wetlands in urban areas is considered sound public policy and can assure continued long-term preservation of such wetlands, provision of attendant public benefits, and prevention of serious and costly environmental damage. Acquisition of wetlands, even those wetlands regulated by the Wisconsin Department of Natural Resources, is desirable for the following reasons:

1. Changes to existing regulations—Wetland protection regulations currently administered by state or federal agencies could be changed; wetlands now protected but not publicly owned would then be subject to encroachment or conversion to urban use.

2. Outdoor recreation use—Certain wetlands are needed for recreational purposes and, under the park and open space plan, are recommended for acquisition for park and outdoor recreation use.

3. Wetlands management—Wetlands which are acquired by a public agency can be managed to promote a variety of public benefits. In addition, the public agency can take steps to prevent illegal dumping, filling, or misuse of such wetlands.

4. Use for other public purposes—Wetland areas, because they are low and sometimes follow intermittent and perennial streams, may be necessary for location of certain utilities, such as sanitary sewers, flood control structures, or floodwater storage areas. If wetlands are in public ownership, the provision of such public facilities can be expedited while assuring sensitive treatment of wetland resources.

5. Taxation fairness—Wetlands which are currently regulated by state and federal agencies are so regulated to prevent a public harm and generally cannot be used for intensive urban purposes. The public sector should be willing and ready to accept title to such wetlands. Private wetlands owners could donate such wetlands to the public, receive a tax benefit as part of that donation, and no longer be taxed for lands which they cannot readily use.

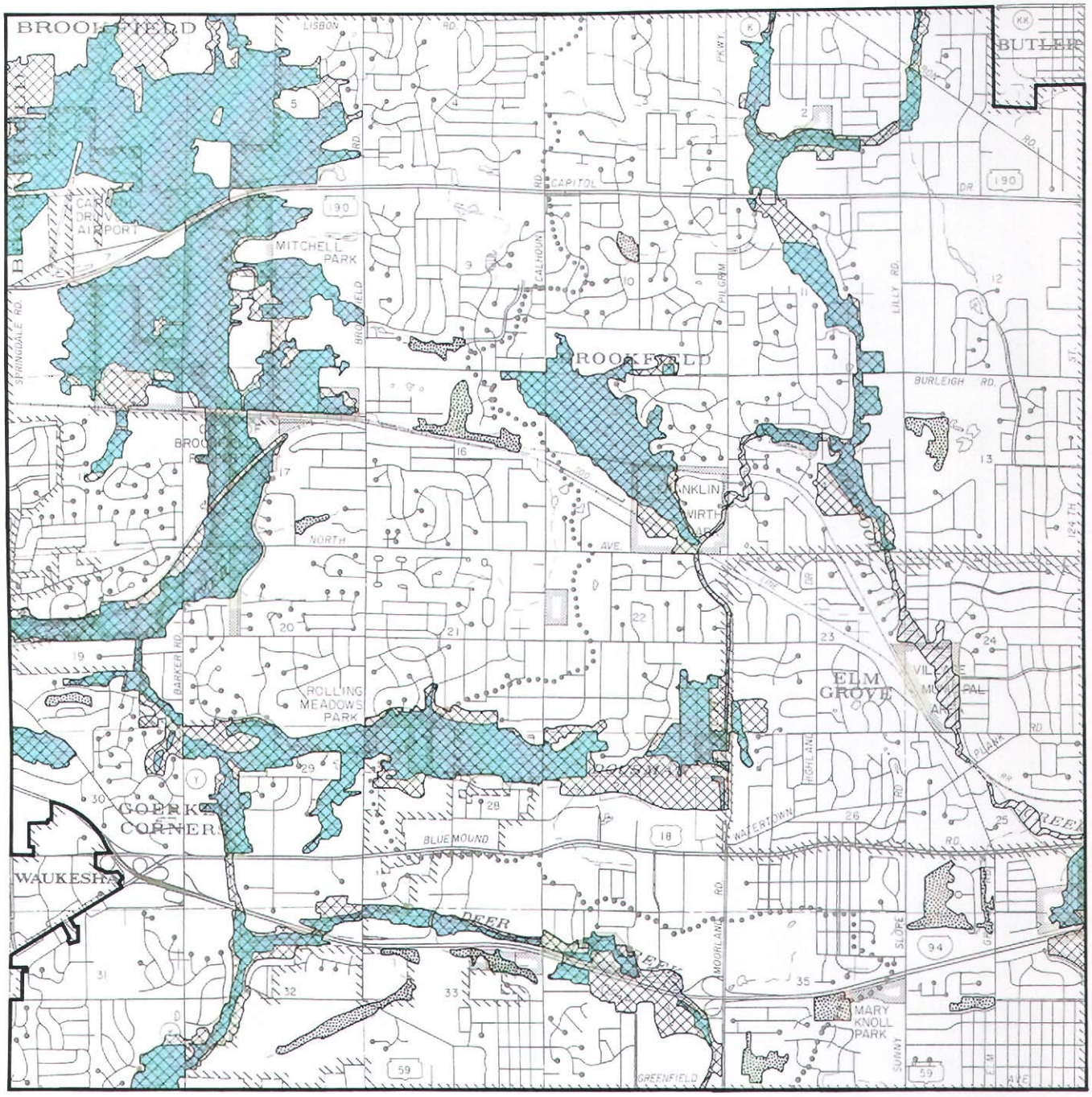
6. Open space preservation—In urban areas, open lands, including wetlands, can provide relief from intensive urban uses, and there is often strong public interest in acquisition of wetlands to assure their continued use for open space purposes.

The location of wetlands within the primary environmental corridor, and additional large wetlands (five acres or larger in size) are shown on Map A-5, while the recommendations for the acquisition of wetlands in these two categories are shown on Maps A-6 and A-7, respectively, and are summarized in Table A-4. As indicated in Table A-4, of the total 3,229 acres of wetlands in the study area, about 3,040 acres, or about 94 percent, are located within the primary environmental corridors; and about 189 acres, or about 6 percent, are additional large wetlands. Wetlands smaller than five acres in size are shown on Map A-8.

As further indicated in Table A-4, of the 3,229 acres of wetlands in the study area, about 892 acres, or about 28 percent, are held in existing park or open space site ownership. Under the park and open space plan and the wetlands acquisition plan for the City of Brookfield, it is recommended that about 299 acres of wetlands, or about 9 percent, be acquired for public park or recreation trail use; and that about 2,038 acres, or about 63 percent, be acquired for other public open space use. Of the 2,308 acres of wetlands in the City of Brookfield, about 847 acres, or about 37 percent, are in existing park or open space ownership. Under the park and open space and wetlands acquisition plans, it is recommended that about 229 acres, or about 10 percent, be acquired for public park or recreation trail use; and that about 1,232 acres, or about 53 percent, be acquired for other public open space use.

Map A-5

WETLANDS WITHIN PRIMARY ENVIRONMENTAL CORRIDORS IN THE BROOKFIELD STUDY AREA



LEGEND

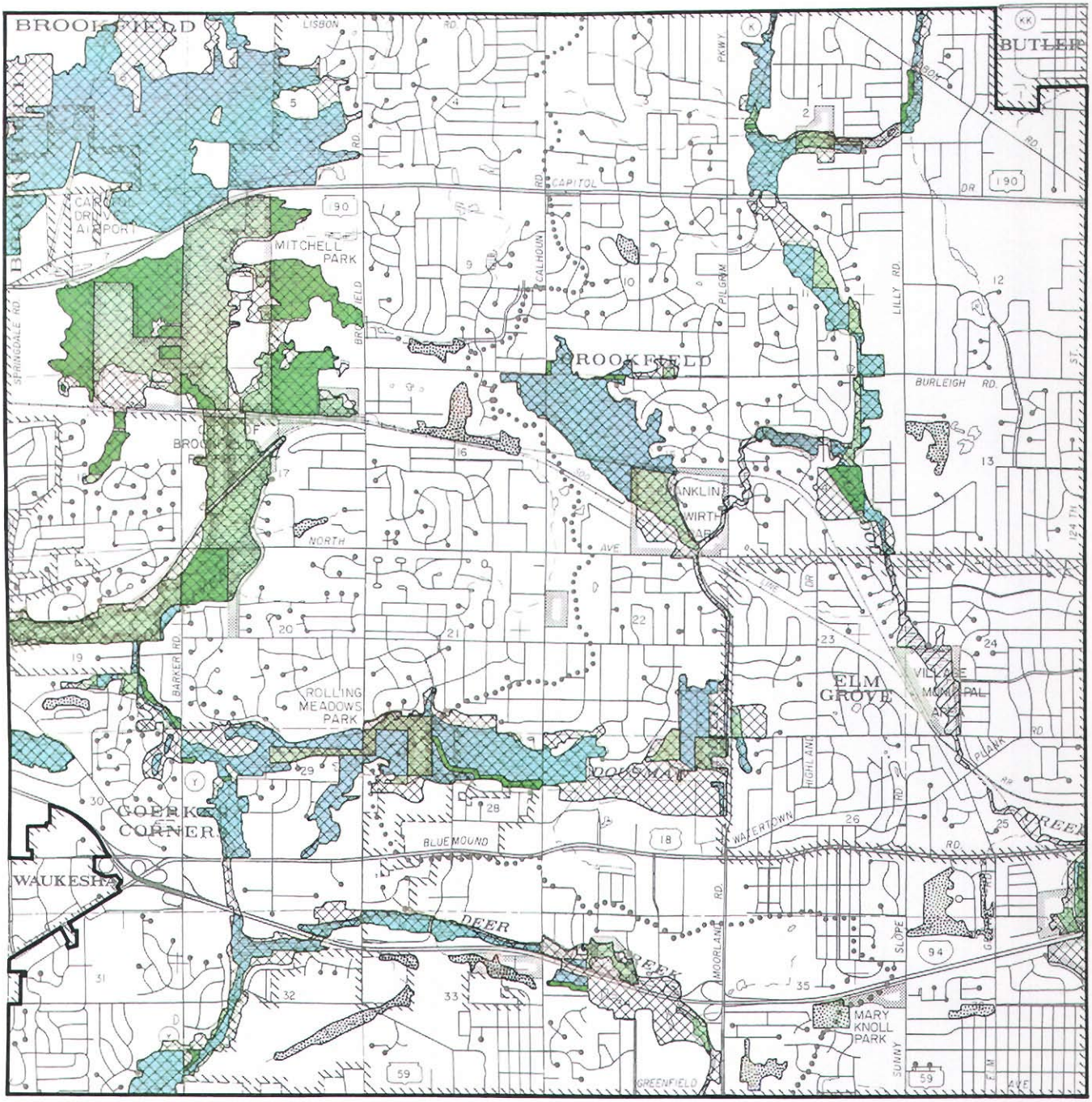
- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA
- WETLANDS WITHIN PRIMARY ENVIRONMENTAL CORRIDOR

GRAPHIC SCALE
0 1/4 1/2 MILE
0 2000 4000 FEET

Source: SEWRPC.

Map A-6

RECOMMENDATIONS FOR PRESERVATION OF WETLANDS WITHIN THE PRIMARY ENVIRONMENTAL CORRIDORS



LEGEND

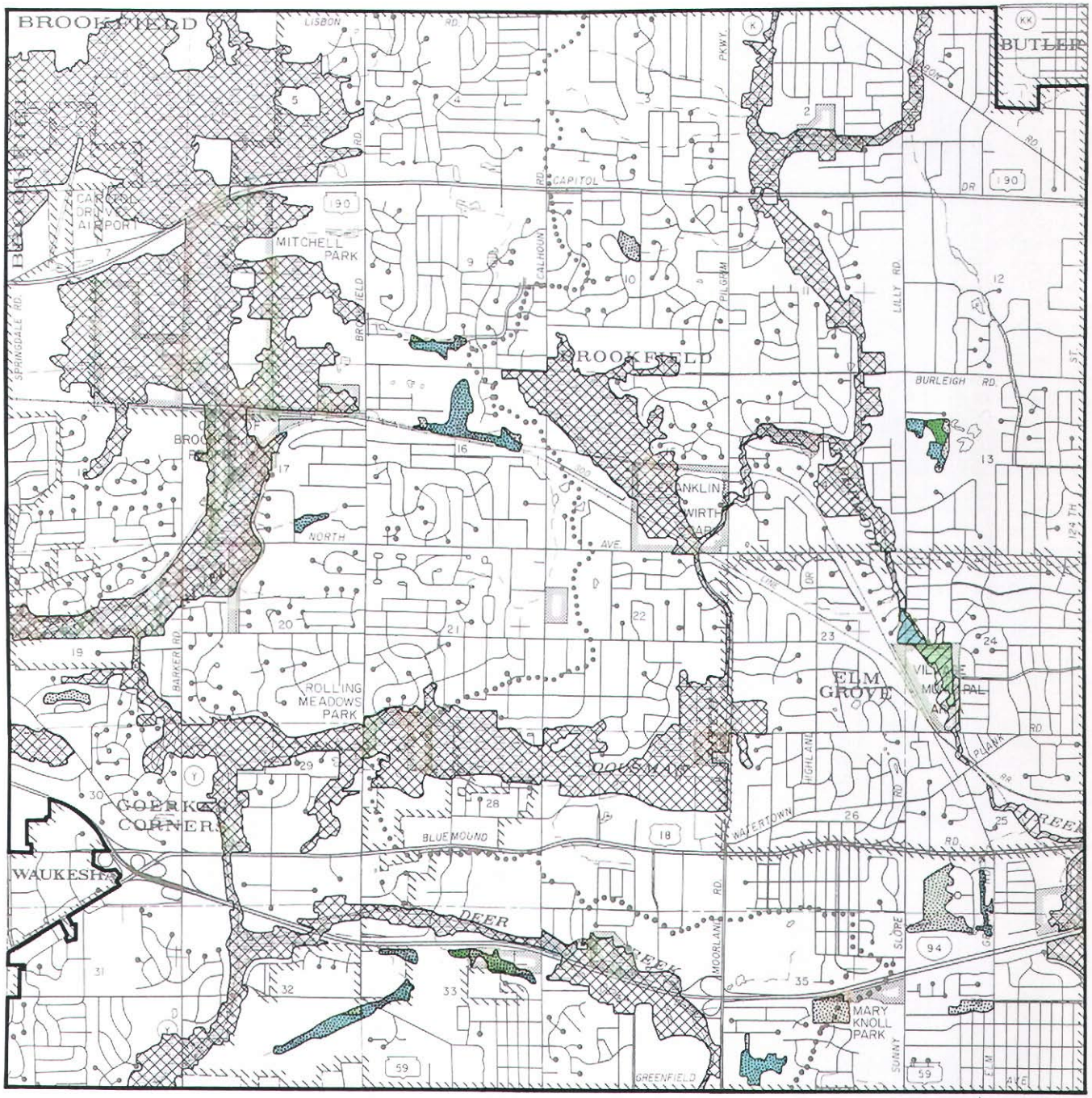
- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA
- EXISTING PUBLIC OWNERSHIP
- PROPOSED PUBLIC PARK AND OUTDOOR RECREATION SITE
- PROPOSED OTHER PUBLIC OPEN SPACE SITE

GRAPHIC SCALE
0 1/4 1/2 MILE
0 2000 4000 FEET

Source: SEWRPC.

Map A-7

RECOMMENDATIONS FOR PRESERVATION OF WETLANDS FIVE ACRES OR LARGER IN SIZE OUTSIDE THE PRIMARY ENVIRONMENTAL CORRIDORS



LEGEND

- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA
- EXISTING PUBLIC OWNERSHIP
- PROPOSED PUBLIC PARK AND OUTDOOR RECREATION SITE
- PROPOSED OTHER PUBLIC OPEN SITE

GRAPHIC SCALE
0 1/4 1/2 MILE
0 2000 4000 FEET

Source: SEWRPC.

Table A-4

RECOMMENDATIONS FOR PROTECTION OF WETLANDS IN THE BROOKFIELD STUDY AREA

Civil Division	Wetlands Within Primary Environmental Corridor (acres)				Additional Large—Five Acres or More—Wetlands (acres)				Wetlands Within Primary Environmental Corridor and Additional Large Wetlands (acres)			Total (acres)
	Existing Park or Other Public Site	Proposed Park or Recreation Trail	Proposed Other Public Open Space Use	Subtotal	Existing Park or Other Public Site	Proposed Park or Recreation Trail	Proposed Other Public Open Space Use	Subtotal	Existing Park or Other Public Site	Proposed Park or Recreation Trail	Proposed Other Public Open Space Use	
City of Brookfield	828[a]	223	1,101[b]	2,152	19	6	131	156	847	229	1,232	2,308
Town of Brookfield	22	70[c]	784[b]	876	--	--	2	2	22	70	786	878
Village of Elm Grove	6	--	6	12	17	--	14	31	23	--	20	43
Study Area	856	293	1,891[b]	3,040	36	6	147	189	892	299	2,038	3,229

[a] *Includes all wetlands in Mitchell Park and about 18 acres of wetlands in compatible private open space use.*

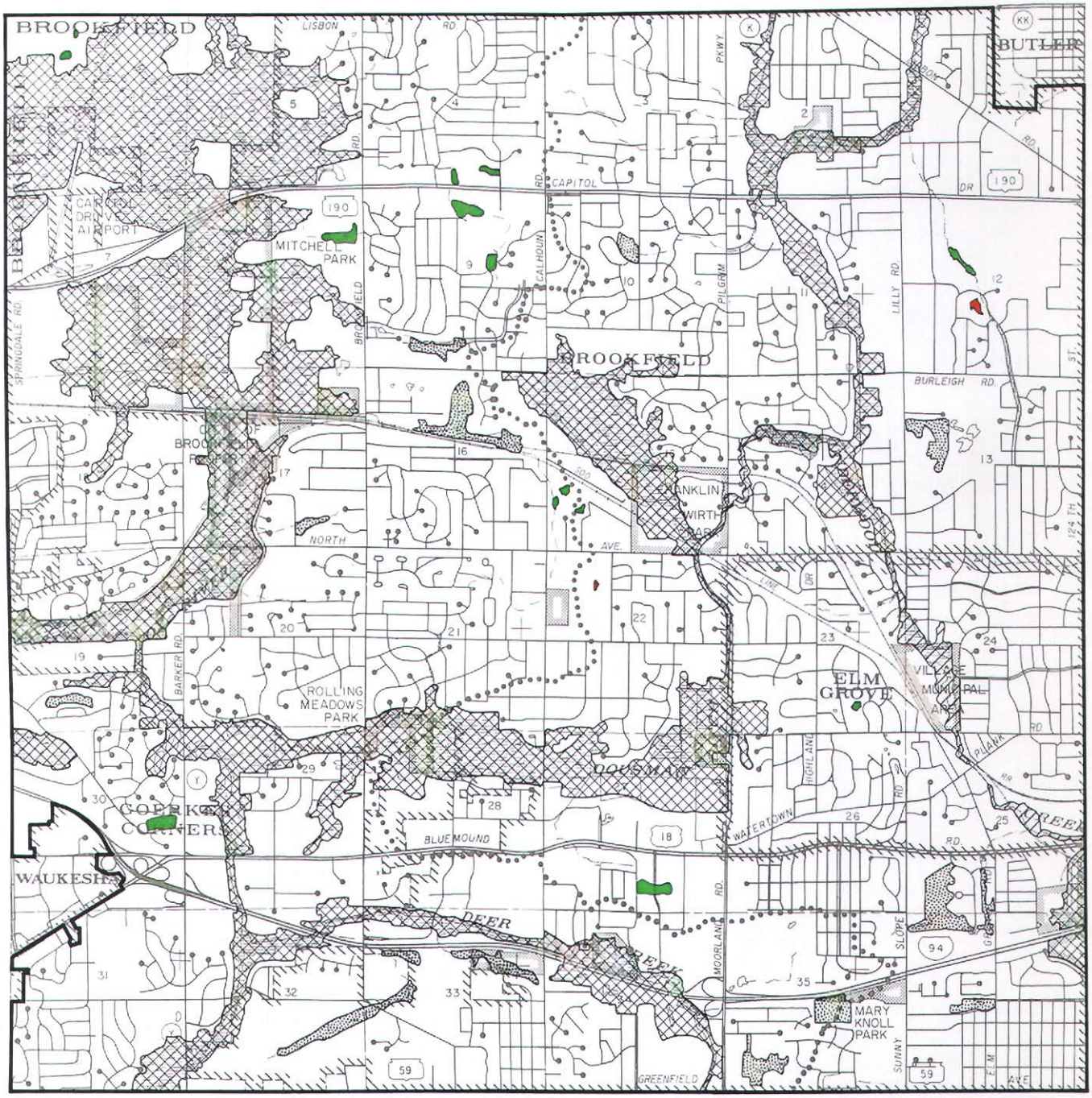
[b] *Under regional and county park and open space plans, it is envisioned that about 831 acres, or about 44 percent of the 1,891 acres proposed for acquisition for other public open space use, would be acquired by Waukesha County as part of the proposed Fox River Parkway. Of this total, about 305 acres are located within the City of Brookfield and 526 acres are within the Town of Brookfield.*

[c] *Under the park and open space plan for the City of Brookfield, about 64 acres would be acquired as part of the proposed addition to Mitchell Park.*

Source: City of Brookfield Park and Recreation Commission and SEWRPC.

Map A-8

WETLANDS LESS THAN FIVE ACRES IN SIZE OUTSIDE OF PRIMARY ENVIRONMENTAL CORRIDORS



Source: SEWRPC.

Appendix C

PRESERVATION OF FLOODLANDS WITHIN PRIMARY ENVIRONMENTAL CORRIDORS IN THE BROOKFIELD STUDY AREA

INTRODUCTION

Under the park and open space plan for the City of Brookfield, it is recommended that primary environmental corridors be preserved in natural, open uses. Recognizing the importance of undeveloped floodlands to the overall environmental health and quality of life within the City, the City of Brookfield Plan Commission on January 16, 1989, formed a Wetlands Management Task Force, which was to be responsible for the preparation of a wetlands preservation plan for the City; and, on April 14, 1989, the Task Force requested that the Regional Planning Commission, as part of the open space preservation element of the park and open space plan for the City of Brookfield, provide detailed inventory information on wetlands and floodlands in the Brookfield study area; identify those wetlands and floodlands necessary for park and related outdoor recreation uses; and prepare a wetlands preservation plan for the City. The wetlands preservation plan, set forth in Appendix A, was approved by the Task Force on November 8, 1989.

The wetlands preservation plan included specific recommendations for the acquisition of wetlands within floodlands in the primary environmental corridors within the City. However, those floodlands used for agricultural purposes and other floodlands not covered by wetland vegetation within the primary environmental corridors were not addressed within the wetland preservation plan. On June 12, 1990, the City of Brookfield Plan Commission requested that the Wetlands Management Task Force develop recommendations for the preservation of floodlands in agricultural use and other undeveloped floodlands not encompassed by wetlands within a primary environmental corridor. The general policy for preservation of such floodlands is set forth in this appendix.

The first section of this appendix presents inventory information on floodlands in the primary environmental corridors in the Brookfield study area; while the second section presents recommendations for the preservation of such floodlands.

Floodlands Within the Primary Environmental Corridor

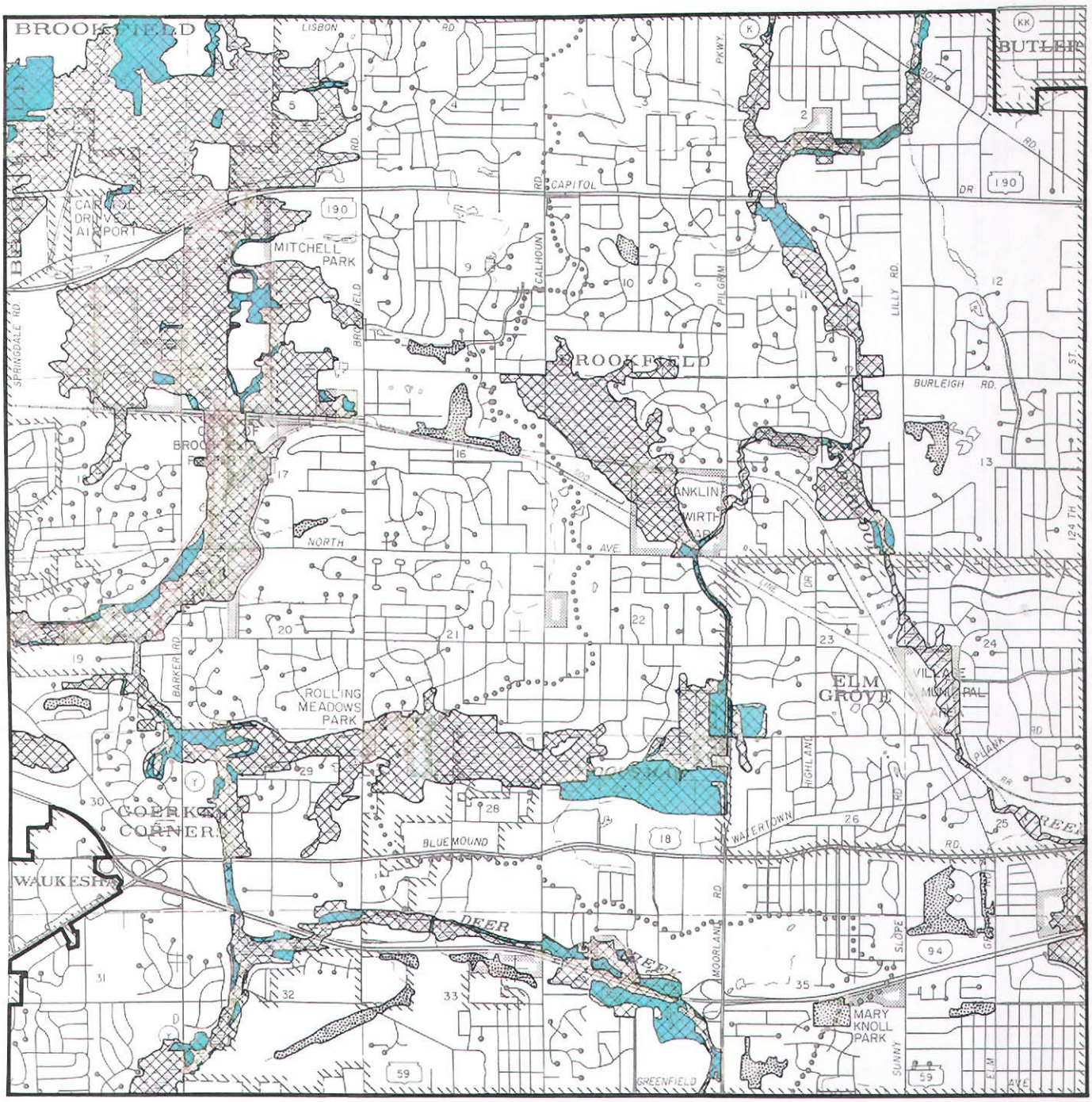
As indicated in Chapter II and in Appendix A of this report, there were in 1989 about 3,670 acres of floodlands in the Brookfield study area. As shown on Map C-1, of this total, about 601 acres of primary environmental corridor lands consist of floodlands not lying within a wetland within a primary environmental corridor. As further shown on Map C-1, about 391 acres, or about 65 percent of the 601 acres of such floodlands, were in 1989 located within the City of Brookfield.

Preservation of Floodlands Within the Primary Environmental Corridors

Under the park and open space plan for the City of Brookfield, it is recommended that all wetlands and all additional undeveloped lands within the 100-year recurrence interval floodplain within any primary environmental corridor be preserved in natural, open uses and be acquired where appropriate by the City. At its meeting on June 19, 1990, the Wetlands Management Task Force concurred with this recommendation. More specifically, the Task Force recognized that floodlands in an urbanizing area formerly used for agricultural purposes, if left undeveloped, will generally revert to wetlands and provide flood storage and other benefits; and the Task Force recommended that such floodlands be acquired, upgraded, and restored to wetlands when located within a designated primary environmental corridor. In addition, the Task Force recognized that the margins of such floodlands can be reconfigured when such action contributes to the restoration of wetlands and preservation of the corridor. Finally, the Task Force recommended that an easement held by the City providing for public access and permitting floodland management, especially for the future construction of flood control structures and other flood control measures, be considered as an acceptable substitute for fee simple acquisition of the lands concerned.

Map C-1

FLOODLANDS NOT ENCOMPASSING WETLANDS IN THE PRIMARY ENVIRONMENTAL CORRIDORS IN THE BROOKFIELD STUDY AREA



LEGEND

- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA
- FLOODLANDS NOT ENCOMPASSING WETLANDS IN THE PRIMARY ENVIRONMENTAL CORRIDOR

GRAPHIC SCALE
0 1/4 1/2 MILE
0 2000 4000 FEET

Source: SEWRPC.

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Appendix B

EXAMPLE OF MATERIAL PUBLISHED AS PART OF CITY OF BROOKFIELD INFORMATIONAL AND EDUCATIONAL EFFORTS DIRECTED TOWARD SOLVING LOCAL HOMEOWNERS' FLOODING AND SANITARY SEWER BACKUP PROBLEMS

STORMWATER FLOODING & SANITARY SEWER BACKUPS

CAUSES, PREVENTIONS AND CLEAN-UP TIPS

JUNE 1999

IMPORTANT NOTICE OF DISCLAIMER

The material contained in this brochure is offered for informational purposes only. The City does not warrant or guarantee the effectiveness of any of the alternatives discussed. Individual properties must be assessed on a case by case basis by the property owner and appropriate professionals in the area of flood proofing.

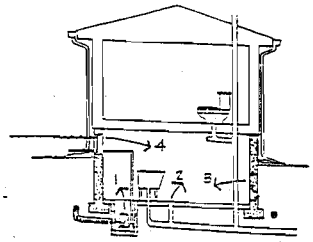
Reference: *Protecting Your Home from Flood Damage. Revised 1996. 2nd Edition.* Federal Emergency Management Agency

2

CAUSES

There are four ways water can get into your basement:

1. Through the drainage tile system's sump.
2. Backing up through the sanitary sewer lines under the house.
3. Seeping through cracks in the walls and floors.
4. Over the surface of the ground through windows and doorways.

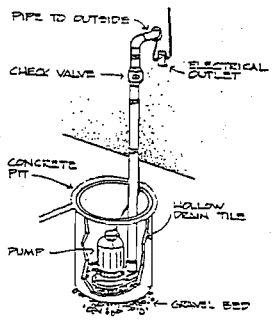


1. SUMP BACKUP

The sump in your drainage system is directly connected to the drain tiles, and therefore to the water in the ground outside your basement walls. A sump will back up when the pump fails, when the power fails, or when the pump is overloaded.

The first condition can be prevented by proper pump maintenance and operation according to the manufacturer's owner's manual. This includes periodic cleaning of the debris screen, even during high water. A clogged intake is as bad as having no pump.

One of the most common causes of basement flooding is not pump failure, but electrical failure. Power losses often accompany severe storms. Backup systems with batteries or generators are available commercially and experienced flood victims will tell you they are well worth the cost.



******SAFETY NOTE******

Be sure your backup generator exhausts to the outdoors. Just like your car engine, a gasoline powered generator creates deadly carbon monoxide gas.

****

Pump overload occurs when there is more groundwater coming into the drain tiles than the pump can handle. There are two methods to prevent this. One method is to have a second or even a third pump on hand. Each pump should have its own outflow pipe. The second method is to make sure the outflow pipes drain on top of the ground, well away from the house. The City of Brookfield does not allow sump pumps to drain into the municipal sanitary sewer system because it overloads the system pumps or treatment facilities.

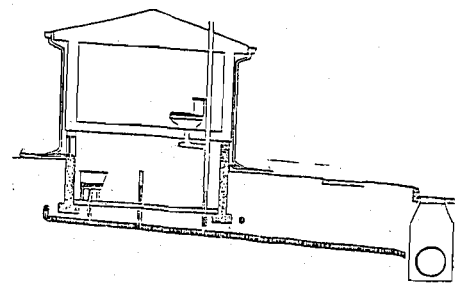
2. SEWER BACKUP

A sanitary sewer backup occurs when the municipal system is overloaded with clear water from inflow and infiltration. There are four ways to protect against this type of backup: install a standpipe, a plug, a back water valve, or an overhead/hung sewer. High volumes of clear water overload the system and backups occur in basements.

STANDPIPE

A pipe inserted or screwed into the floor drain will allow the sewer backup to seek its own level without flowing into your basement. The pipe need only be tall enough to be higher than street level. As water rises, it will flow out of the sanitary sewer manholes into the street, rather than out of the floor drain.

A standpipe may be more dependable than a plug that could pop out. However, one shortcoming of a standpipe is that one must be home to install it.



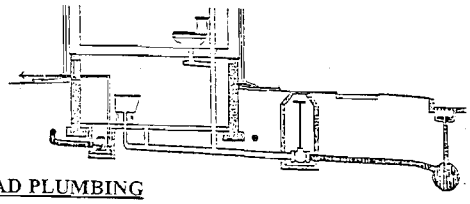
PLUG

Since the basement floor drain in the lowest point in your house, it is the first place of entry for backed up sewage. The drain can be closed with a rubber or wooden plug during heavy rains. Some drains are threaded for a screw-in plug. Plugs can usually be brought at a hardware or plumbing supply store. This is the simplest and cheapest way to stop sewer backup. However, the sewer could backup into the next higher opening, probably a sink drain or toilet.

VALVE

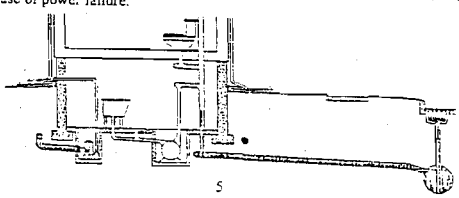
A backwater valve installed in the sewer line is more expensive than a plug or a standpipe. However, there are several advantages. Valves operate automatically, are a permanent part of your system and prevent the sewer from backing up into the basement.

A backwater valve may require periodic maintenance, and therefore must have an access point so it can be cleaned or repaired.



OVERHEAD PLUMBING

Your plumbing can be rebuilt so that the basement sewage drains to a sump. Sewage is then pumped up to the height of the sewer system's manhole. From this height, it flows by gravity into the system. The sewer system will back up onto the street before it could get high enough to back up into your house. Just as with a sump pump, pumps for overhead plumbing require a back up system in case of power failure.



3. SEEPAGE

Whether from heavy local rains and water standing in your yard, broken or plugged drain tiles or surface flooding, the ground around your house can become saturated with water. If there are cracks in your walls or floors, saturated ground will allow seepage of water into your basement.

The best ways to deal with seepage are to ensure that walls are waterproof and to relieve the groundwater through subsurface drain tiles. Cracks can be repaired and the walls can be waterproofed from inside or outside. Waterproofing on the outside of the wall is more effective because groundwater pressure forces the sealer into the foundation. The best technique is to dig a ditch around the basement wall and apply a commercial sealant. Drain tile systems have proven very effective in dealing with high groundwater. Water is kept away from the walls by draining down to the drain tiles. Water flows to the sump and is pumped out. Therefore, one of the best protections against seepage is to ensure you have a drain system and sump pump that work properly.

4. SURFACE STORMWATER FLOODING

One of the most serious types of damage to your basement will come from flood waters on top of the ground. This is caused from overflow of a nearby stream, or if your building is located in a low spot, from the collection of runoff from heavy rains.

One of the first responses to this sort of flooding is to seal the openings, such as the windows. This can be done by replacing windows with glass blocks or raising window wells above the water level. A low wall can be built around the stairwells.

The biggest problem with closing the direct openings to your basement is that water will still stand on the ground next to your house and will likely seep down along the walls. However, unlike other seepage problems, surface flooding will deliver more water than your sump pumps can handle. Split levels, bi-levels and houses with the basement floor no more than three or four feet below ground level are probably strong enough to deal with this, especially if the walls are built of concrete. However, if the difference in flood heights and the floor of the basement is greater than three feet and the wall is made of block or masonry, the most effective method of preventing water from reaching the walls is through proper grading or creating swales to divert water away from the home.

Remember to be a considerate neighbor and make sure your actions do not interfere with drainage on adjacent properties.

PREVENTIONS

Once the source of water has been determined, the following information may be used to remedy the problems. Consult a professional in your area for assistance.

Sump Pumps

Sump: A hole designed to collect water.

Sump Pump: Used to remove water from basements and other low areas.

A sump consists of a perforated liner set in a hole lined with coarse stone. The stone helps collect water and filter out fine particles. A filter cloth may extend the life of the sump by preventing it from silting up. Perforated water-collection pipes draining to the sump make it more effective.

A sump pump is usually either the submersible type with a motor and impeller under water, or the pedestal type with the impeller under water and motor on top. Both types have an automatic switch. Both types will work until the electricity is shorted by the water. With the submersible type, this happens at the end of the electrical supply wire. With the pedestal type, it happens when the water reaches the motor on top of the pedestal. Both types should have a one-way valve that will not allow the water to flow back into the discharge hose or pipe.

Caution:

Electricity and water are a hazardous combination. The sump pump must be wired into a grounded receptacle that only allows one plug. A second nearby outlet should be equipped with a ground fault circuit interrupter (GFCI). This second outlet should be handy so that people working near the sump pump will not be tempted to unplug it to use the outlet, thereby placing themselves in danger.

Installing a Floor Drain Plug

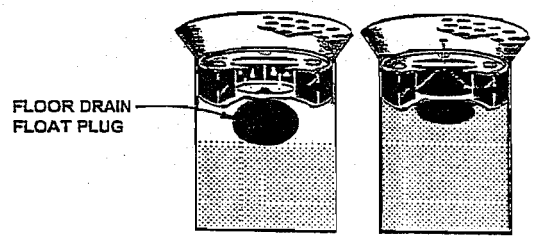
The easiest way to stop sewer backup is to plug the opening where the backup can first enter the house. The sanitary system's lowest opening in the house is the floor drain. Commercial plugs are available that can be placed in the floor drain below the grate. Bolts on metal end pieces are tightened, causing a rubber gasket to expand and seal the plug in the pipe.

A plug not only stops water from entering the house but it prevents it from leaving the house as well. Because of this, it may be best to put the plug in place only during heavy rains.

You may install a plug with a float. The float allows water to drain out of the basement. When the sewer backs up, the float rises and plugs the drain. A float plug permanently installed will not interfere with the floor drain's normal operation.

Caution:

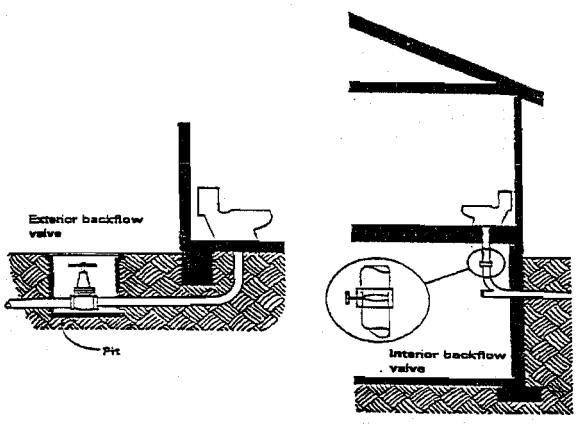
- → Float plugs may be blocked open by even small amounts of debris.
- → Floor drain plugs do not stop backup from coming out of the next lowest opening, for example a laundry tub or basement toilet.
- → In older houses the sewer lines under the basement floor may be clay tile. A build up of water pressure can damage the sewer lines.



Certain repairs are not permitted for substantially damaged buildings. Check with your local building official or floodplain administrator before beginning repairs.

Installing a Backflow Valve

The sewage/septic system is designed to remove sewage from a house. If flood water enters the system, the sewage can backup and enter your home. To help prevent this, install a backflow valve in the sewer line. The backflow valve is opened by the flow of sewage exiting your home, but closes when the flow reverses preventing sewage from backing up into your home. Check with your local building official for permitting and code requirements. It is recommended that this work be done by a qualified, licensed plumbing contractor.



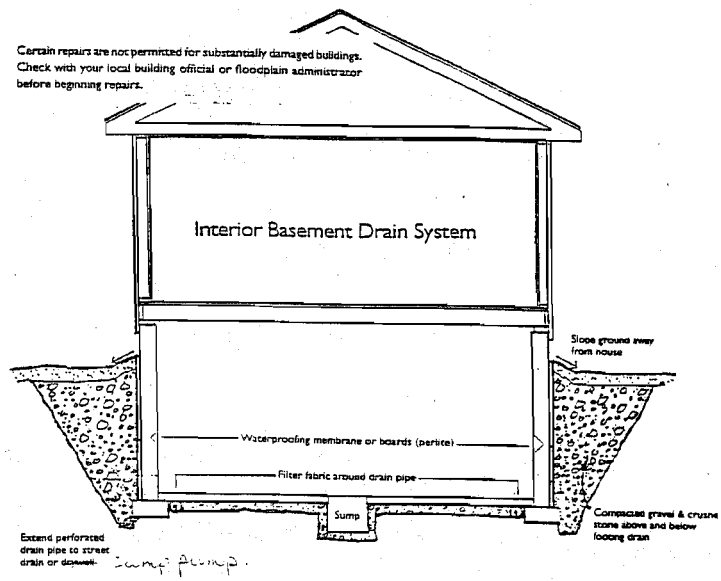
Certain repairs are not permitted for substantially damaged buildings. Check with your local building official or floodplain administrator before beginning repairs.

Installing an Interior Foundation Drainage System

Some homes need a basement foundation drain system to collect and carry away groundwater. This may involve cutting the floor slab, excavating a trench and installing drains along the inside perimeter of all footings. These drains should slope to a low point from which a single line can carry the water away from the house, or to a sump pump.

The basement drainage retrofit depicted below is a simple, generic system utilizing perforated drain pipe, wrapped in filter fabric, and imbedded in crushed stone. Other, more sophisticated systems, some of which are patented, are available to correct serious basement drainage problems. Consult an architect, engineer or licensed specialty contractor for specific information and recommendations regarding system alternatives.

Certain repairs are not permitted for substantially damaged buildings. Check with your local building official or floodplain administrator before beginning repairs.

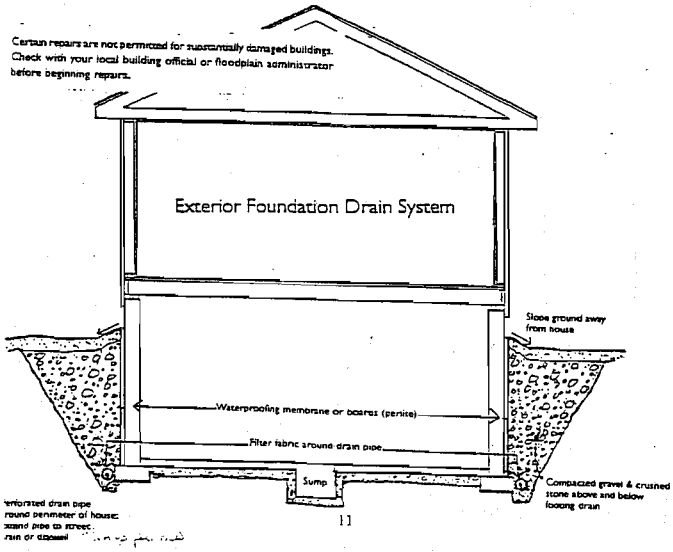


Installing an Exterior Foundation Drainage System

All houses need a well-developed drain system to collect and carry away groundwaters. This means establishing drains around all footings with perforated pipe surrounded by crushed stone backfill to drain water that seeps through the ground. These drains should slope to a low point from which a single line should carry the water away from the house, to a sump pump which discharges to a storm sewer, or to the ground surface away from the house.

A 4" deep bed of gravel under the lab should allow water to run to a central collection point where there is a sump pump with a continuous power source. If you have a lot of water under the slab, you may need to install perforated pipe drain lines to carry the water to the sump pump.

As with other retrofitting systems, a sealed house will usually need a sewer backflow protection device.



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Sealing Openings In Walls

If your house is being flooded by flowing waters entering through windows or doors, you can temporarily close up those openings during a flood and keep that water out.

Metal or wooden shields can be made to fit the openings. These can then be secured to the openings with bolts or slid into special positioning channels to stop the flow of water. On the inside, the shields need to have a special rubber gasket or they should be installed with a bead of caulking to make them water tight. Sandbags can also be stacked in doorways or window wells and vents to make the openings water resistant.

NOTE: Houses should be shielded from floodwater entry, but generally shielded not more than 1 ½ feet. Exterior water deeper than this could push the walls in if there is no water inside to push back with equal force.

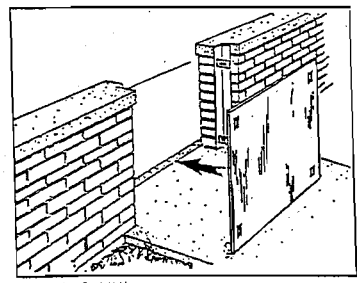
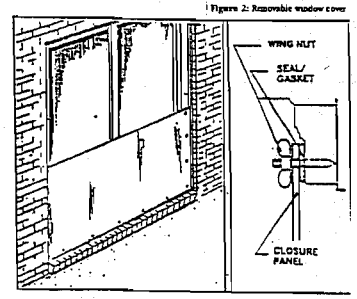


Figure 1: Bolt-on flood shield

Figure 2: Removable window cover



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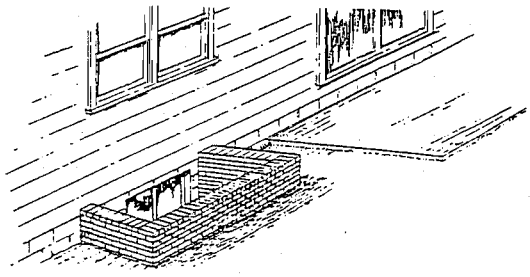
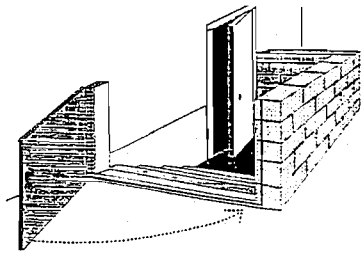
Installing an Exterior Floodwall

An exterior floodwall can protect a window well or stair against low level flash flooding. Walls should be supported by and securely tied into a footing so that they will not be undercut by scouring. Flood walls can be constructed of masonry or concrete. It is important to understand the flood situation you are working with and your soil conditions in order to properly evaluate if a flood wall is the right solution for you. Flood walls are not effective when the ground becomes saturated.



Construct a watertight masonry flood wall around the perimeter of the opening. The wall should not exceed three feet in height and must be constructed of properly reinforced poured concrete or sufficient concrete masonry units to prevent failure under flood conditions. Install proper footing and anchor to existing walls. Install a watertight, spring-loaded steel access door and watertight gaskets on sides and bottom of frame at any necessary opening. Be sure all work conforms to State and local building codes.



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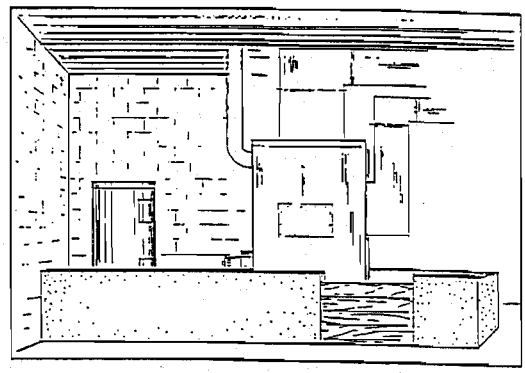
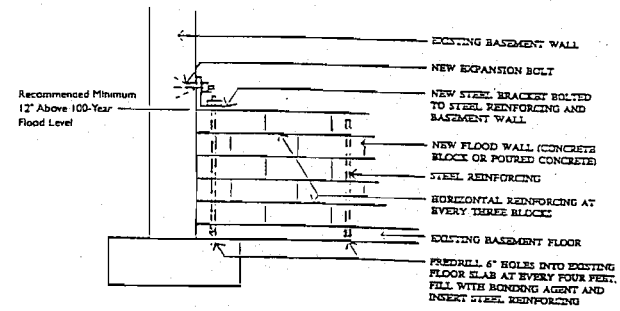


An interior flood wall can be built to accommodate low levels of flooding. The wall must enclose the utilities and be built 1 foot above the 100 year flood elevation. The wall must be constructed of either concrete blocks or poured concrete and reinforced with steel rods in order to be able to resist the pressure of the floodwaters. It is important to anchor the new wall into the existing basement wall and floor so that it is not pushed around by the floodwaters. For best protection, do not install gates which open into the enclosure.



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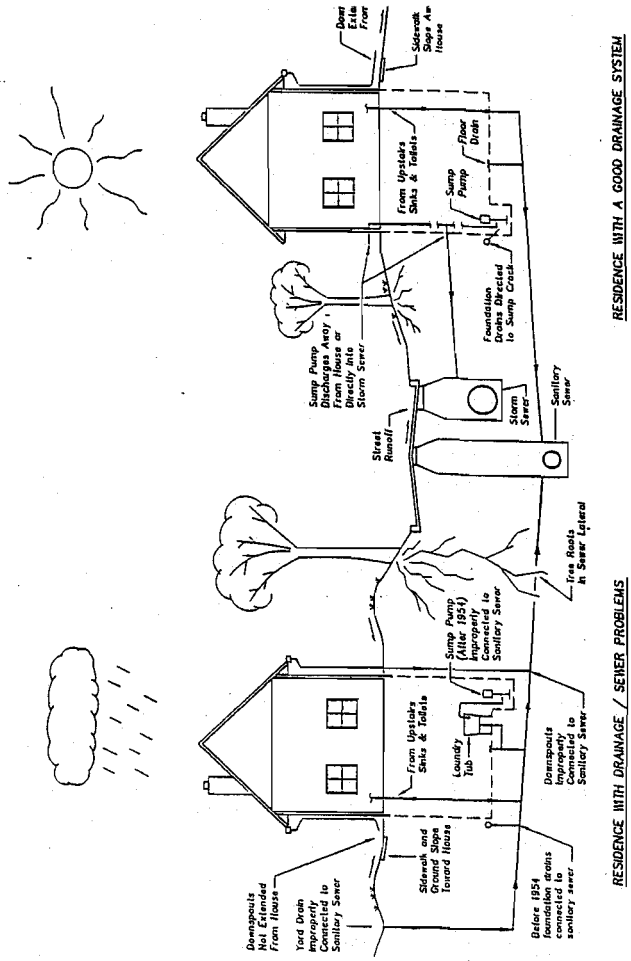
Helpful Information on Maintaining a Dry Basement



PAINTS

Completely dry the surface before painting. This may take several weeks, but paint will peel if applied over a damp surface. Coat concrete surfaces with penetrating sealer for easier future cleanup. Coat water-stained areas with shellac or commercial stain killer first or the stains will bleed through the paint. Dryproofing requires thick plastic or rubberized sheeting. Waterproofing paints do not keep out floodwaters.

Windows

The best protection from high wind damage is boarding up all windows or installing hurricane shutters. Taping windows will not prevent storm breakage. To board up windows, cut plywood to fit all doors and windows. Label for quick pairing of coverings and openings. Store with the nails/fasteners for attachment.

Water Resistant Products

→ Concrete, concrete block, or glazed brick

→ Clay, concrete, or ceramic tile

→ Indoor-outdoor carpeting, synthetic backing (not fastened down)

→ Vinyl, terrazzo, or rubber floor covering, with waterproof adhesives

→ Metal doors and window frames

→ Polyester-epoxy paints (Warning: do not use mildew-resistant paint indoors as it contains a toxic ingredient).

→ Stone, slate, cast stone with waterproof mortar

→ Mastic, silicone, polyurethane formed-in place flooring

→ Polystyrene plastic foam insulation

→ Water-resistant glue

CLEAN-UP TIPS

The most important thing to remember is to give your house plenty of time to dry! Rushing to rebuild before everything dries can cause many problems. The rule of thumb is, if it takes a week for visible moisture to disappear, it will take at least another week for unseen parts to dry. Here are some inexpensive measures you can take to make your recovery easier after the next flood.

UTILITIES

Electrical: Move the main breaker or fuse box and utility meters above the flood level for your house. Label each circuit. If the electrical code allows, raise the electrical outlets and switches above the flood level.

Equipment: If you plan to replace a flooded furnace, water heater, or air conditioner, install the new one on a higher floor. If your new air conditioner or heat pump will be outside, install it on a platform above your flood level. A water heater can be put anywhere near a hot water pipe. An updraft furnace in a basement can be replaced with a downdraft furnace on a floor above the flood protection level. Heavy appliances may be placed on raised platforms inside the house where the flood protection level is not too high. Make sure washers/dryers will not vibrate off the blocks or platform during use. A one or two foot waterproof floodwall around appliances will protect them from shallow flooding.

WALLS

Wash and disinfect the studs and sills if the wallboard and insulation were removed. If rebuilding, consider metal studs and sills as they are less damaged by water than wooden ones. Pressure-treated wood resists mildew and wood-eating insects but may swell when soaked. **Warning: Some pressure-treated wood should not be used inside the house. It depends on the chemicals used to treat them. Ask your lumber company for consumer information that gives specific precautions.**

WALLBOARD

If you install the wall board horizontally (four feet high), you'll only have to replace half the wall if the next flood is less than 4 feet deep.

Leave the wall open 1 inch above the sill. The baseboards will hide the gap, but all you have to do next floodtime is remove the baseboard and the wall cavity will drain freely and air will circulate better. (Not applicable if local code requires a fire wall).

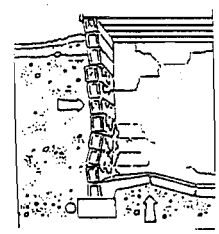
Greenboard or other moisture-resistant wallboard may be more sturdy than regular wallboard, but replacement is required as it presents the same health hazards when soaked with floodwaters.

FLOORS

Particle board or plywood fall apart when wet for lengthy periods. Floor joists and some wood floors regain their shape when naturally dried. Use screws or screw nails on floors and stairs to minimize warping. Completely dry subflooring before laying new flooring or carpeting. Reseal, then sand or place a new underlayment for a new floor.

Pumping Out a Flooded Basement

If your basement is flooded, don't rush to pump it out.



Water in the ground outside your house will still be pushing hard against the outside of your basement walls, and the water inside your basement faster than the water outside drains out of the ground, the outside pressure will be greater than the inside pressure, causing walls and floor to crack and possible collapse.

How to Safely Pump Water Out of your Basement

→ Never go into a flooded basement unless you are sure the electricity is off.
→ Start pumping the water out of the basement when floodwaters no longer cover the ground.
→ Don't use gasoline-powered pumps or generators indoors. Gasoline engines create deadly carbon monoxide exhaust fumes.
→ Pump the water level down 2 or 3 feet. Mark the level, and wait overnight.
→ Check the water level the next day. If the water level went back up over your mark, it is still too early to drain your basement. Wait 24 hours, then pump the water down 2 or 3 feet again. Mark the level and check it the next day.
→ When the water stops rising, pump down another 2 or 3 feet and wait overnight. Repeat steps 4 and 5 until all water is pumped out of the basement.

What to Do After *Draining Your Basement*

→ Disinfect the floors and walls to remove bacteria left from the floodwaters.
→ Before turning the power back on, check any electrical service that may have been damaged. Replace any wiring, switches, outlets that were wet during the flood.
→ Remove heating and air conditioning vents or registers as soon as possible and hose out the ductwork. Those ducts that were flooded will have mud and bacteria in them.
→ Check your water system for leaks in pipes that may have been moved.
→ Check your water supply to be certain it is not contaminated.
→ Check all other utilities and drains for damage from the floodwaters.

CITY OF BROOKFIELD
Community Development Department 796-6646
2000 North Calhoun Road, Brookfield, WI 53005-5095 6/99

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Appendix C

EXCERPT FROM SEWRPC PLANNING REPORT NO. 26, VOLUME TWO, SETTING FORTH OBJECTIVES, PRINCIPLES, AND STANDARDS USED IN PREPARING THE COMPREHENSIVE PLAN FOR THE MENOMONEE RIVER WATERSHED

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BASIC CONCEPTS AND DEFINITIONS

The term "objective" is subject to a wide range of interpretation and application, and is closely linked to other terms often used in planning work which are equally subject to a wide range of interpretation and application. The following definitions have, therefore, been adopted in order to provide a common frame of reference:

1. Objective: a goal or end toward the attainment of which plans and policies are directed.

2. Principle: a fundamental, primary, or generally accepted tenet used to support objectives and prepare standards and plans.

3. Standard: a criterion used as a basis of comparison to determine the adequacy of plan proposals to attain objectives.

4. Plan: a design which seeks to achieve the agreed-upon objectives.

5. Policy: a rule or course of action used to ensure plan implementation.

6. Program: a coordinated series of policies and actions to carry out a plan.

Although this chapter deals primarily with the first three of these terms, an understanding of the interrelationship of the foregoing definitions and the basic concepts which they represent is essential to the following discussion of development objectives, principles, and standards.

WATERSHED DEVELOPMENT OBJECTIVES

Objectives, in order to be useful in the watershed planning process, must not only be logically sound and related in a demonstrable and measurable way to alternative physical development proposals, but must also be consistent with, and grow out of, regionwide development objectives. This is essential if the watershed plans are to comprise integral elements of a comprehensive plan for the physical development of the Region, and if sound coordination of regional and watershed development is to be achieved.

The Southeastern Wisconsin Regional Planning Commission has, in its planning efforts to date, adopted, after careful review and recommendation by various advisory and coordinating committees, nine general regional development objectives, nine specific regional land use development objectives, seven specific regional transportation system development objectives, four specific sanitary sewerage system development objectives, and four specific water control facility development objectives. These, together with their supporting principles and standards, are set forth in previous Commission planning reports. Certain of these objectives and supporting standards are directly applicable to the Menomonee River watershed planning effort, and are hereby recommended for adoption as development objectives for the Menomonee River watershed.

Land Use Development Objectives

Six of the nine specific regional land use development objectives adopted by the Commission under its regional land use-transportation planning program are directly applicable to the Menomonee River watershed planning effort.[1] These are:

1. A balanced allocation of space to the various land use categories which meets the social, physical, and economic needs of the regional population.

2. A spatial distribution of the various land uses which will result in the protection, wise use, and development of the natural resources of the Region.

3. A spatial distribution of the various land uses which is properly related to the supporting transportation, utility, and public facility systems in order to assure the economical provision of utility and municipal services.

4. The preservation and provision of open space to enhance the total quality of the regional environment, maximize essential natural resource availability, preserve and protect natural areas and wildlife habitat, give form and structure to urban development, and facilitate the ultimate attainment of a balanced year-round outdoor recreational program providing a full range of facilities for all age groups.

5. The preservation of land areas for agricultural uses in order to provide for certain special types of agriculture, provide a reserve for future needs, and ensure the preservation of those rural areas which provide wildlife habitat and are essential to shape and order urban development.

6. The attainment of good soil and water conservation practices in order to reduce storm water runoff, soil erosion, and stream and lake sedimentation, pollution, and eutrophication.

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[1] *The other three specific regional land use development objectives are: 1) a spatial distribution of the various land uses which will result in a compatible arrangement of land uses; 2) the development and conservation of residential areas within a physical environment that is healthy, safe, convenient, and attractive; and 3) the preservation and provision of a variety of suitable industrial and commercial sites both in terms of physical characteristics and location.*

Sanitary Sewerage System Planning Objectives

Three of the four specific sanitary sewerage system development objectives adopted by the Commission under its regional sanitary sewerage system planning effort are directly applicable to the Menomonee River watershed planning effort.[2] These are:

1. The development of sanitary sewerage systems which will effectively serve the existing regional urban development pattern and promote implementation of the regional land use plan, meeting the anticipated sanitary waste disposal demand generated by the existing and proposed land uses.

2. The development of sanitary sewerage systems that are properly related to, and that will enhance the overall quality of, the natural and man-made environments.

3. The development of sanitary sewerage systems that are both economical and efficient, meeting all other objectives at the lowest cost possible.

Water Control Facility Development Objectives

Three of the four specific water control facility development objectives adopted by the Commission under its other comprehensive watershed planning programs are also applicable to the Menomonee River watershed planning effort.[3] These are:

1. An integrated system of drainage and flood control facilities and floodland management programs which will effectively reduce flood damage under the existing land use pattern of the watershed and promote the implementation of the watershed land use plan, meeting the anticipated runoff loadings generated by the existing and proposed land uses.

2. An integrated system of land management and water quality control facilities and pollution abatement devices adequate to ensure a quality of surface water necessary to meet the water uses shown on Map 1.

3. The attainment of sound groundwater resource development and protective practices to minimize the possibility for pollution and depletion of the groundwater resources.

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[2] *The other specific sanitary sewerage system development objective is: The development of sanitary systems so as to meet established water use objectives and supporting water quality standards.*

[3] *The other specific water control facility development objective is: An integrated system of land management and water quality control facilities and pollution abatement devices adequate to ensure a quality of lake water necessary to achieve established water use objectives.*

Principles and Standards

Complementing each of the foregoing specific land use, water control facility, and sanitary sewerage system development objectives is a planning principle which supports the objective and asserts its inherent validity, and a set of quantifiable planning standards which can be used to evaluate the relative or absolute ability of alternative plan designs to meet the stated development objective. These principles and standards, as they apply to watershed planning and development, are set forth in Tables 2, 3, and 4, and serve to facilitate quantitative application of the objectives during plan design, test, and evaluation.

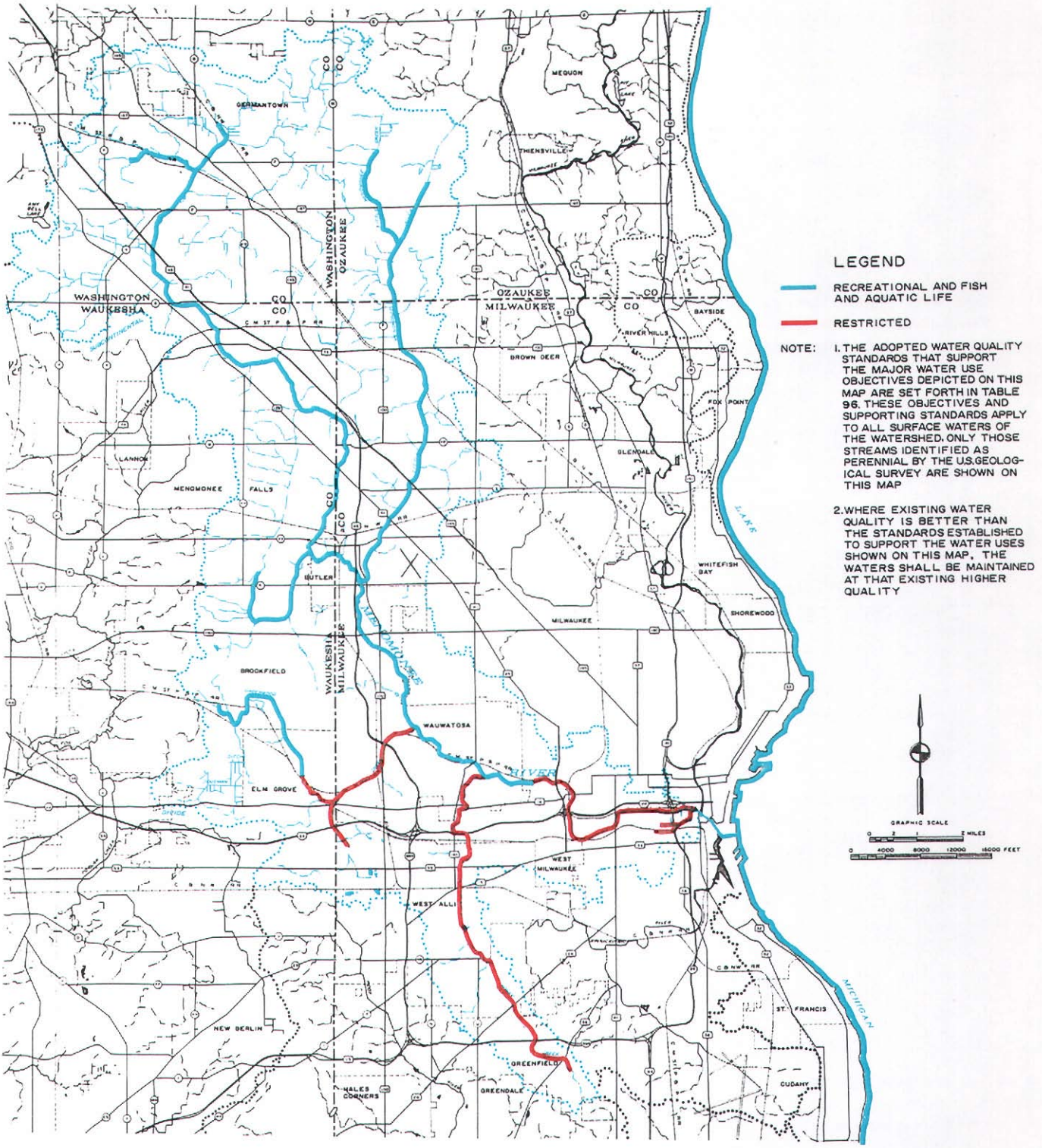
It should be noted that the planning standards herein recommended for adoption fall into two groups: comparative and absolute. The comparative standards, by their very nature, can be applied only through a comparison of alternative plan proposals. Absolute standards can be applied individually to each alternative plan proposal, since they are expressed in terms of maximum, minimum, or desirable values. The standards set forth herein should serve not only as aids in the development, test, and evaluation of watershed land use and water control facility plans but also in the development, test, and evaluation of local land use and community facility plans and in the development of plan implementation policies and programs as well.

Overriding Considerations

In the application of the watershed development objectives, principles, and standards in the preparation and evaluation of the watershed plan elements, several overriding considerations must be recognized. First, it must be recognized that any proposed water control and water quality management facilities must constitute integral parts of a total system. It is not possible from an application of the standards alone, however, to assure such a system integration, since the standards cannot be used to determine the effect of individual facilities and controls on each other or on the system as a whole. This requires the application of planning and engineering techniques developed for this purpose, such as hydrologic, hydraulic, and water quality simulation, to quantitatively test the potential performance of the proposed facilities as part of a total system, thereby permitting adjustment of the spatial distribution and capacities of the facilities and system to the existing and future runoff and waste loadings as derived from the land use plan. Second, it must be recognized that it is unlikely that any one plan proposal will meet all the standards completely; and the extent to which each standard is met, exceeded, or violated must serve as a measure of the ability of each alternative plan proposal to achieve the specific objectives which the given standard complements. Third, it must be recognized that certain objectives and standards may be in conflict and require resolution through compromise, such compromise being an essential part of any design effort.

Map 1

RECOMMENDED WATER USE OBJECTIVES FOR THE MENOMONEE RIVER WATERSHED



Water use objectives and supporting water quality standards constitute a significant input to the preparation of the comprehensive plan for the Menomonee River watershed. The existing state-adopted water use objectives for the surface waters of the Menomonee River watershed are identified on Map 82, Volume 1 of this report. The recommended water use objectives for the Menomonee River watershed are shown on the above map. The two maps differ in only one respect: that reach of the main stem of the Menomonee River from its confluence with Honey Creek in the City of Wauwatosa downstream to Hawley Road in the City of Milwaukee, which has been placed in the "restricted" category under the current state-adopted objectives, is recommended for upgrading to the "recreational and fish and aquatic life" category under the recommended Menomonee River watershed plan.

Source: SEWRPC.

Table 2

LAND USE DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS FOR THE MENOMONEE RIVER WATERSHED

OBJECTIVE NO. 1

A balanced allocation of space to the various land use categories which meets the social, physical, and economic needs of the regional population.

PRINCIPLE

The planned supply of land set aside for any given use should approximate the known and anticipated demand for that use.

STANDARDS

1. For each additional 1,000 persons to be accommodated within the Region at each residential density, the following minimum amounts of land should be set aside:

Residential Density Category	Net Area[a] (Acres/1,000 Persons)	Gross Area[b] (Acres/1,000 Persons)
High Density Urban[c]	24	36
Medium Density Urban[c]	65	92
Low Density Urban[c]	238	298
Suburban[d]	572	698
Rural[d]	1,429	1,681

In addition, for each additional 1,000 persons to be accommodated within the Region the following minimum amounts of land should be set aside:

Land Use Category	Net Area[a] (Acres/1,000 Persons)	Gross Area[e] (Acres/1,000 Persons)
Governmental and Institutional	9	12
Public Park and Recreation		
Major	4	5
Other	9	10

2. For the daily use of short-term visitors to the watershed, the following amounts of land should be acquired and developed for each anticipated 100 participants[f] in each of the five major outdoor recreational activities which require intensive land development within the watershed:

Major Activity	Total Acres	Principal Development Acres	Backup Land or Secondary Development Acres
Swimming[g]	0.45	0.09	0.36
Picnicking[h]	12.50	1.25	11.25
Golfing[i]	32.79	32.79	--
Camping[j]	133.33	6.67	126.66
Skiing[k]	3.70	3.33	0.37

3. For each additional 100 commercial and industrial employees to be accommodated within the Region, the following minimum amounts of land should be set aside:

Land Use Category	Net Area[a] (Acres/100 Employees)	Gross Area[l] (Acres/100 Employees)
Commercial		
Major	1	3
Other	2	6
Industrial	2	9

OBJECTIVE NO. 2

A spatial distribution of the various land uses which will result in the protection, wise use, and development of the natural resources of the Region.

PRINCIPLE

The proper allocation of uses to land can assist in maintaining an ecological balance between the activities of man and the natural environment which supports him.

A. Soils

Principle

The proper relation of urban and rural land use development to soils type and distribution can serve to avoid many environmental problems, aid in the establishment of better regional settlement patterns, and promote the wise use of an irreplaceable resource.

STANDARDS

1. Sewered urban development, particularly for residential use, should not be located in areas covered by soils identified in the regional detailed operational soil survey as having severe or very severe limitations for such development.

2. Unsewered suburban residential development should not be located in areas covered by soils identified in the regional detailed operational soil survey as having severe or very severe limitations for such development.

3. Rural development, including agricultural and rural residential development, should not be located in areas covered by soils identified in the regional detailed operational soil survey as having severe or very severe limitations for such uses.

B. Wetlands

Principle

Wetlands support a wide variety of desirable and sometimes unique plant and animal life; assist in the stabilization of lake levels and stream-flows; trap and store plant nutrients in runoff, thus reducing the rate of enrichment of surface waters and obnoxious weed and algae growth; contribute to the atmospheric oxygen supply; contribute to the atmospheric water supply; reduce storm water runoff by providing area for floodwater impoundment and storage; trap soil particles suspended in runoff and thus reduce stream sedimentation; and provide the population with opportunities for certain scientific, educational, and recreational pursuits.

STANDARD

All wetland areas[m] adjacent to streams or lakes, all wetlands within areas having special wildlife and other natural values, and all wetlands having an area in excess of 50 acres should not be allocated to any urban development except limited recreation and should not be drained or filled. Adjacent surrounding areas should be kept in open-space use, such as agriculture or limited recreation.

C. Woodlands[n]

Principle

Woodlands assist in maintaining unique natural relationships between plants and animals; reduce storm water runoff; contribute to the atmospheric oxygen supply; contribute to the atmospheric water supply through transpiration; aid in reducing soil erosion and stream sedimentation; provide the resource base for the forest product industries; provide the population with opportunities for certain scientific, educational, and recreational pursuits; and provide a desirable aesthetic setting for certain types of land use development.

STANDARDS

1. A minimum of 10 percent of the land area of each watershed[o] within the Region should be devoted to woodlands.

2. For demonstration and educational purposes, the woodland cover within each county should include a minimum of 40 acres devoted to each major forest type: oak-hickory, northern hardwood, pine, and lowland forest. In addition, remaining examples of the native forest vegetation types representative of the pre-settlement vegetation should be maintained in a natural condition and be made available for research and educational use.

3. A minimum regional aggregate of five acres of woodland per 1,000 population should be maintained for recreational pursuits.

D. Wildlife[p]

Table 2 (continued)

Principle

Wildlife, when provided with a suitable habitat, will provide the population with opportunities for certain scientific, educational, and recreational pursuits; comprises an integral component of the life systems which are vital to beneficial natural processes, including the control of harmful insects and other noxious pests and the promotion of plant pollination; provides a food source; provides an economic resource for the recreation industries; and is an indicator of environmental health.

STANDARD

The most suitable habitat for wildlife—that is, the area wherein fish and game can best be fed, sheltered, and reproduced—is a natural habitat. Since the natural habitat for fish and game can best be obtained by preserving or maintaining other resources in a wholesome state, such as soil, air, water, wetlands, and woodlands, the standards for each of these other resources, if met, would ensure the preservation of a suitable wildlife habitat and population.

OBJECTIVE NO. 3

A spatial distribution of the various land uses which is properly related to the supporting transportation, utility, and public facility systems in order to assure the economical provision of utility and municipal services.

PRINCIPLE

The transportation and public utility facilities and the land use pattern which these facilities serve and support are mutually interdependent in that the land use pattern determines the demand for, and loadings upon, transportation and utility facilities; and these facilities, in turn, are essential to, and form a basic framework for, land use development.

STANDARDS

1. The transportation system should be located and designed to minimize the penetration of existing and proposed residential neighborhood units by through traffic.

2. The transportation system should be located and designed to provide access not only to all land presently devoted to urban development but to land proposed to be used for such urban development.

3. Transportation terminal facilities, such as off-street parking, should be located in close proximity to the principal land uses to which they are accessory.

4. All land developed or proposed to be developed for urban medium- and high-density residential use should be located in areas serviceable by existing or proposed primary, secondary, and tertiary mass transit facilities.

5. All land developed or proposed to be developed for urban medium-, high-, and low-density residential use should be located in areas serviceable by an existing or proposed public sanitary sewerage system and preferably within the gravity drainage area tributary to such systems.

6. All land developed or proposed to be developed for urban medium-, high-, and low-density residential use should be located in areas serviceable by an existing or proposed public water supply system.

7. Urban development should be located so as to maximize the use of existing transportation and utility systems.

OBJECTIVE NO. 4

The preservation and provision of open space[q] to enhance the total quality of the regional environment, maximize essential natural resource availability, give form and structure to urban development, and facilitate the ultimate attainment of a balanced year-round outdoor recreational program providing a full range of facilities for all age groups.

PRINCIPLE

Open space is the fundamental element required for the preservation, wise use, and development of such natural resources as soil, water, woodlands, wetlands, native vegetation, and wildlife; it provides the opportunity to add to the physical, intellectual, and spiritual growth of the population; it enhances the economic and aesthetic value of certain types of development; and it is essential to outdoor recreational pursuits.

Table 2 (continued)

STANDARDS[r]

1. Local park and recreation open spaces should be provided within a maximum service radius of one-half mile of every dwelling unit in an urban area, and each site should be of sufficient size to accommodate the maximum tributary service area population at a use intensity of 675 persons per acre.

2. Regional park and recreation open spaces should be provided within an approximately one hour travel time of every dwelling unit of the Region, and should have a minimum site area of 250 acres.

3. Areas having unique scientific, cultural, scenic, or educational value should not be allocated to any urban or agricultural land uses; and adjacent surrounding areas should be retained in open space use, such as agriculture or limited recreation.

OBJECTIVE NO. 5

The preservation of land areas for agricultural uses in order to provide for certain special types of agriculture, provide a reserve for future needs, and ensure the preservation of those unique rural areas which provide wildlife habitat and which are essential to shape and order urban development.

PRINCIPLE

Agricultural areas, in addition to providing food and fiber, can provide significant wildlife habitat; ecological balance between plants and animals; provide locations proximal to urban centers for the production of certain food commodities which may require nearby population concentrations for an efficient production-distribution relationship; and provide open spaces which give form and structure to urban development.

STANDARDS

1. All prime agricultural areas[s] should be preserved.

2. All agricultural lands surrounding adjacent high-value scientific, educational, or recreational resources and covered by soils rated in the regional detailed operational soil survey as very good, good, or fair for agricultural use should be preserved.

In addition to the above, attempts should be made to preserve agricultural areas which are covered by soils rated in the regional detailed operational soil survey as fair if these soils: a) generally occur in concentrations greater than five square miles and surround or lie adjacent to areas which qualify under either of the above standards, or b) occur in areas which may be designated as desirable open spaces for shaping urban development.

OBJECTIVE NO. 6

The attainment of good soil and water conservation practices in order to reduce storm water runoff, soil erosion, and stream and lake sedimentation, pollution, and eutrophication.

PRINCIPLE

Good soil and water conservation practices, including mulch tillage, terracing, grassed waterways, contour strip cropping, and suitable crop rotation in rural areas; seeding; sodding; erosion control structures for drainageways; erosion control structures at storm sewer outlets; and proper land development and construction methods and practices, particularly in urban areas, including maximum possible delay in stripping of vegetation, construction of sediment basins, and mulching and revegetating as soon as possible, can assist in reducing storm water runoff, soil erosion, and stream and lake siltation, pollution, and eutrophication.

STANDARDS

1. The area of the watershed in cultivated agricultural use, which has general land slopes greater than 2 percent, should be under district cooperative soil and water conservation agreements and planned conservation treatment.

2. Drainageways should be controlled to eliminate channel erosion both through stabilization of bank and bed materials and by reduction of the channel gradient.

3. All urban and structural plans and developments, where soil and vegetative cover is removed, should include soil and water conservation practices to control erosion on critical areas.

4. Runoff through and from areas with exposed soil should be trapped and stored or retarded to less than critical erosive velocities.

Table 2 (continued)

[a] *Net land use area is defined as the actual site area devoted to a given use, and consists of the ground floor site area occupied by any buildings plus the required yards and open spaces.*

[b] *Gross residential land use area is defined as the net area devoted to this use plus the area devoted to all supporting land uses, including streets, neighborhood parks and playgrounds, elementary schools, and neighborhood institutional and commercial uses, but not including freeways and expressways and other community and areawide uses.*

[c] *Areas served, proposed to be served, or required to be served by public sanitary sewerage and water supply facilities; requires neighborhood facilities.*

[d] *Areas not served, not proposed to be served, nor required to be served by public sanitary sewerage and water supply facilities; does not require neighborhood facilities.*

[e] *Gross governmental and institutional area is defined as the net area devoted to governmental and institutional use plus the area devoted to supporting land uses, including streets and onsite parking. Gross public park and recreation area is defined as the net area devoted to active or intensive recreation use plus the adjacent "backup" lands and lands devoted to other supporting land uses such as roads and parking areas.*

[f] *A participant is defined as a person 12 years of age or older who actively participates in a particular recreational activity on a given day.*

[g] *Swimming—One acre of developed beach area can accommodate approximately 370 people at any one time. With a daily turnover rate of 3.0, the maximum capacity of one acre of developed beach is 1,110 people per acre per day. In addition, for every one acre of developed beach area, four (4) acres of backup lands are required to provide necessary parking area (approximately one and one-half acres), concession services, dressing room area (approximately one acre), and other activity area, such as picnic area (approximately one and one-half acres).*

[h] *Picnicking—One acre of developed picnic area with a maximum of 16 tables can accommodate approximately 50 people at any one time. With a daily turnover rate of 1.6, the maximum capacity of one acre of developed picnic area is 80 people per acre per day. In addition, for every one acre of developed picnic area, nine (9) acres of backup land are required to provide necessary parking area and additional secondary facilities.*

[i] *Golfing—A minimum of 10 acres of land per hole is required to develop a regulation 9- or 18-hole golf course, including area for clubhouse and parking, and will accommodate approximately one golfer per acre at any one time. With a daily turnover rate of 3.0, the maximum capacity of each golf course is 3.0 golfers per acre per day, or 30 golfers per hole per day.*

[j] *Camping—One acre of developed camp area with a maximum of five camp units can accommodate approximately 15 people per day. There is no daily turnover rate for camping. In addition, for every one acre of developed camp area, nineteen (19) acres of backup land are required to provide necessary supporting activities or facilities, such as central convenience facilities, hiking and nature trails, picnic areas, boat and canoe launching sites, and horseback trails.*

[k] *Skiing—One acre of developed ski slope can accommodate approximately 10 people at any one time. With a daily turnover rate of 3.0, the maximum capacity of one acre of developed ski slope is 30 people per acre per day. In addition, for every 10 acres of developed ski slope, one acre of backup land is required to provide parking and concession facilities. The recommended minimum site area is 100 acres.*

[l] *Gross commercial and industrial area is defined as the net area devoted to these uses plus the area devoted to supporting land uses, including streets and off-street parking.*

[m] *Wetlands are defined as those lands which are wholly or partially covered with hydrophytic plants and wet and spongy organic soils, and which are generally covered with shallow standing water, intermittently inundated, or have a high water table.*

[n] *Woodlands are defined as lands at least 20 acres in area which are covered by a dense, concentrated stand of trees and associated undergrowth.*

[o] *A watershed, as used herein, is defined as a portion of the surface of the earth occupied by a surface dainage system discharging all surface water runoff to a common outlet and which is 25 square miles or larger in areal extent.*

[p] *Includes all fish and game.*

[q] *Open space is defined as land or water areas which are generally undeveloped for residential, commercial, or industrial uses and are or can be considered relatively permanent in character. It includes areas devoted to park and recreation uses and to large land-consuming institutional uses, as well as areas devoted to agricultural use and to resource conservation, whether publicly or privately owned.*

[r] *It was deemed impractical to establish spatial distribution standards for open space, per se; therefore, only the park and recreation component of the open space land use category is listed in the standards, according to its local or regional orientation. These local park and recreation spaces may include playlots, playgrounds, playfields, and neighborhood parks. Regional park and recreation spaces include large county or state parks. Other open spaces which are not included in this spatial distribution standard are: forest preserves and arboreta; major river valleys; lakes; zoological and botanical gardens; stadia; woodland, wetland, and wildlife areas; scientific areas; and agricultural lands whose location must be related to, and determined by, the natural resource base.*

[s] *Prime agricultural areas are defined as those areas which a) contain soils rated in the regional detailed operational soil survey as very good or good for agriculture and b) occur in concentrated areas over five square miles in extent which have been designated as exceptionally good for agricultural production by agricultural specialists.*

Source: SEWRPC.

Table 3

SANITARY SEWERAGE SYSTEM DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS FOR THE MENOMONEE RIVER WATERSHED

OBJECTIVE NO. 1

The development of sanitary sewerage systems which will effectively serve the existing regional urban development pattern and promote implementation of the regional land use plan, meeting the anticipated sanitary waste disposal demand generated by the existing proposed land uses.

PRINCIPLE

Sanitary sewerage systems are essential to the development and maintenance of a safe, healthy, and attractive urban environment, and the extension of existing sanitary sewerage systems and the creation of new systems can be effectively used to guide and shape urban development both spatially and temporally.

STANDARDS

1. Sanitary sewer service should be provided to all existing areas of medium-[a] or high-density[b] urban development and to all areas proposed for such development in the regional land use plan.

2. Sanitary sewer service should be provided to all existing areas of low-density[c] urban development and to all areas proposed for such development in the regional land use plan, where such areas are contiguous to areas of medium- or high-density urban development. Where noncontiguous low-density and suburban[d] development already exists, the provision of sanitary sewer service should be contingent upon the inability of the underlying soil resource base to properly support onsite absorption waste disposal systems.

3. Where public health authorities declare that public health hazards exist because of the inability of the soil resource base to properly support onsite soil absorption waste disposal systems, sanitary sewer service should be provided.

4. Lands designated as primary environmental corridors on the regional land use plan should not be served by sanitary sewers, except that development incidental to the preservation and protection of the corridors, such as parks and related outdoor recreation areas, and existing clusters of urban development in such corridors, may be provided with sanitary sewer service. Engineering analyses relating to the sizing of sanitary sewerage facilities should assume the permanent preservation of all undeveloped primary environmental corridor lands in natural open-space uses.

5. Floodlands[e] should not be served by sanitary sewers, except that development incidental to the preservation in open-space uses of floodlands, such as parks and related outdoor recreation areas, and existing urban development in floodlands not recommended for eventual removal in comprehensive watershed plans, may be provided with sanitary sewer service. Engineering analyses relating to the sizing of sewerage facilities should not assume ultimate development of floodlands for urban use.

6. Significant concentrations[f] of land covered by soils found in the regional soil survey to have very severe limitations for urban development even with the provision of sanitary sewer service should not be provided with such service. Engineering analyses relating to the sizing of sewerage facilities should not assume ultimate urban development of such lands for urban use.

7. The timing of the extension of sanitary sewerage facilities should, insofar as possible, seek to promote urban development in a series of complete neighborhood planning units, with service being withheld from any new units in a given municipal sewer service area until previously served units are substantially developed and until existing units not now served are provided with service.

8. The sizing of sewerage facility components should be based upon an assumption that future land use development will occur in general accordance with the land use pattern recommended in the regional land use plan.

9. To the extent feasible, industrial wastes, except clear cooling waters as well as the sanitary wastes generated at industrial plants, should be discharged to municipal sanitary sewerage systems for ultimate treatment and disposal. The necessity to provide pretreatment for industrial wastes should be determined on an individual case-by-case basis.

OBJECTIVE NO. 2

The development of sanitary sewerage systems that are properly related to, and that will enhance the overall quality of, the natural and man-made environments.

Table 3 (continued)

PRINCIPLE

The improper location, design, construction, operation, and maintenance of sewerage system components can adversely affect the natural and man-made environments; therefore, every effort should be made in such actions to properly relate to these environments and minimize any disruption or harm thereto.

STANDARDS

1. New and replacement sewage treatment plants, as well as additions to existing plants, should, wherever possible, be located on sites lying outside of the 100-year recurrence interval floodplain. When it is necessary to use floodplain lands for sewage treatment plants, the facilities should be located outside of the floodway so as to not increase the 100-year recurrence interval flood stage, and should be floodproofed to a flood protection elevation of two feet above the 100-year recurrence interval flood stage so as to assure adequate protection against flood damage and avoid disruption of treatment and consequent bypassing of sewage during flood periods. In the event that a floodway has not been established, or if it is necessary to encroach upon an approved floodway, the hydraulic effect of such encroachment should be evaluated on the basis of an equal degree of encroachment for a significant reach on both sides of the stream, and the degree of encroachment should be limited so as not to raise the peak stage of the 100-year recurrence interval flood by more than 0.5 foot.

2. Existing sewage treatment plants located in the 100-year recurrence interval floodplain should be floodproofed to a flood protection elevation of two feet above the 100-year recurrence interval flood stage so as to assure adequate protection against flood damage and avoid disruption of treatment and consequent bypassing of sewage during flood periods.

3. The location of new and replacement sewage treatment plants should be properly related to the existing and proposed future urban development pattern as reflected in the regional land use plan and any community or neighborhood unit development plans prepared pursuant to, and consistent with, the regional land use plan.

4. New and replacement sewage treatment plants, as well as additions to existing plants, should be located on sites large enougn to provide for adequate open space between the plant and existing or planned future urban land uses; should provide adequate area for expansion to ultimate capacity as determined in the regional sanitary sewerage system plan; and should be located, oriented, and architecturally designed so as to complement their environs and to present an attractive appearance consistent with their status as public works.

5. The disposal of sludge from sewage treatment plants should be accomplished in the most efficient manner possible, consistent, however, with any adopted rules and regulations pertaining to air quality control and solid waste disposal.

OBJECTIVE NO. 3

The development of sanitary sewerage systems that are both economical and efficient, meeting all other objectives at the lowest cost possible.

PRINCIPLE

The total resources of the Region are limited, and any undue investment in sanitary sewerage systems must occur at the expense of other public and private investment. Total sewerage system costs, therefore, should be minimized while meeting and achieving all water quality standards and objectives.

STANDARDS

1. The sum of sanitary sewerage system operating and capital investment costs should be minimized.

2. The total number of sanitary sewerage systems and sewage treatment facilities should be minimized in order to effect economies of scale and concentrate responsibility for water quality management. Where physical consolidation of sanitary sewer systems is uneconomical, administrative and operational consolidation should be considered in order to obtain economies in manpower utilization and minimize duplication of administrative, laboratory, storage, sludge disposal, and other necessary appurtenant facilities and equipment.

3. Maximum feasible use should be made of all existing and committed sanitary sewerage facilities. Such facilities should be supplemented with additional facilities only as necessary to serve the anticipated sanitary waste demand generated by substantial implementation of the regional land use plan, while meeting pertinent water quality use objectives and standards.

4. The use of new or improved materials and management practices should be allowed and encouraged if such materials and practices offer economies in materials or construction cost, or if by their superior performance lead to the achievement of water quality objectives at lesser costs.

Table 3 (continued)

5. Sewer systems and sewage treatment facilities should be designed for staged or incremental construction where feasible and economical so as to limit total investment in sewerage facilities and permit maximum flexibility to accommodate changing situations, such as changes in the rate of growth of population and economic activity or changes in water use objectives and standards, and changing technology, such as changes in the technology of sewage conveyance and treatment.

6. When technically feasible and otherwise acceptable, alignments for new sewer construction should coincide with existing public rights-of-way in order to minimize land acquisition or easement costs and disruption to the natural resource base.

7. Clear water inflows and infiltration to the sanitary sewerage system would be eliminated and infiltration should be minimized.

8. Sanitary sewerage systems and storm water drainage systems should be designed and developed concurrently in order to effect engineering and construction economies, as well as to assure the separate function and integrity of each of the two systems; to immediately achieve pollution abatement and drainage benefits of the integrated design; and to minimize disruption of the natural resource base and existing urban development.

[a] *Medium-density residential development is defined as that development having an average number of dwelling units per gross acre of 2.6 and a net lot area per dwelling unit ranging from 6,231 to 18,980 square feet.*

[b] *High-density residential development is defined as that development having an average number of dwelling units per gross acre of 5.8 and a net lot area per dwelling unit ranging from 2,439 to 6,230 square feet.*

[c] *Low-density residential development is defined as that development having an average number of dwelling units per gross acre of 0.8 and a net lot area per dwelling unit ranging from 18,981 to 62,680 square feet.*

[d] *Suburban residential development is defined as that development having an average number of dwelling units per gross acre of 0.30 and a net lot area per dwelling unit ranging from 62,681 to 217,800 square feet.*

[e] *Floodlands are defined as those lands, including the floodplains, floodways, and channels, subject to inundation by the one hundred (100)-year recurrence interval flood or, where such data are not available, the maximum flood of record.*

[f] *Areas over 160 acres in extent.*

Source: SEWRPC.

Table 4

WATER CONTROL FACILITY DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS FOR THE MENOMONEE RIVER WATERSHED

OBJECTIVE NO. 1

An integrated system of drainage and flood control facilities and floodland management programs which will effectively reduce flood damage under the existing land use pattern of the watershed and promote the implementation of the watershed land use plan, meeting the anticipated runoff loadings generated by the existing and proposed land uses.

PRINCIPLE

Reliable local municipal storm water drainage facilities cannot be properly planned, designed, or constructed except as integral parts of an areawide system of floodwater conveyance and storage facilities centered on major drainageways and perennial waterways designed so that the hydraulic capacity of each waterway opening and channel reach abets the common aim of providing for the storage, as well as the movement, of floodwaters. Not only does the land use pattern of the tributary drainage area affect the required hydraulic capacity, but the effectiveness of the floodwater conveyance and storage facilities affects the uses to which land within the tributary watershed, and particularly within the riverine areas of the watershed, may properly be put.

STANDARDS

1. All new and replacement bridges and culverts over perennial waterways shall be designed so as to accommodate, according to the categories listed below, the designated flood events without overtopping of the related roadway or railroad track and resultant disruption of traffic by floodwaters.

   a. Minor and collector streets used or intended to be used primarily for access to abutting properties: a 10-year recurrence interval flood discharge.

   b. Arterial streets and highways, other than freeways and expressways, used or intended to be used primarily to carry heavy volumes of fast, through traffic: a 50-year recurrence interval flood discharge.

   c. Freeways and expressways: a 100-year recurrence interval flood discharge.

   d. Railroads: a 100-year recurrence interval flood discharge.

2. All new and replacement bridges and culverts over perennial waterways, including pedestrian and other minor bridges, in addition to meeting the applicable above-specified requirements, shall be designed so as to accommodate the 100-year recurrence interval flood event without raising the peak stage, either upstream or downstream, more than 0.5 foot above the peak stage for the 100-year recurrence interval flood, as established in the adopted comprehensive watershed plan. Larger permissible flood stage increases may be acceptable for reaches having topographic or land use conditions which could accommodate the increased stage without creating additional flood damage potential upstream or downstream of the proposed structure.

3. The waterway opening of all new and replacement bridges shall be designed so as to readily facilitate the passage of ice floes and other floating debris, and thereby avoid blockages often associated with bridge failure and with unpredictable backwater effects and flood damages. In this respect it should be recognized that clear spans and rectangular openings are more efficient than interrupted spans and curvilinear openings in allowing the passage of ice floes and other floating debris.

4. Certain new or replacement bridges and culverts over perennial waterways, including pedestrian and other minor bridges, so located with respect to the stream system that the accumulation of floating ice or other debris may cause significant backwater effects with attendant danger to life, public health or safety, or attendant serious damage to homes, industrial and commercial buildings, and important public utilities, shall be designed so as to pass the 100-year recurrence interval flood with at least 2.0 feet of freeboard between the peak stage and the low concrete or steel in the bridge span.

5. Standards 1, 3, and 4 shall also be used as the criteria for assessment of the adequacy of the hydraulic capacity and structural safety of existing bridges or culverts over perennial waterways and thereby serve, within the context of the adopted comprehensive watershed plan, as the basis for crossing modification or replacement recommendations designed to alleviate flooding and other problems.

6. Channel modifications, dikes, and floodwalls should be restricted to the minimum number and extent absolutely necessary for the protection of existing and proposed land use development, which development is consistent with the land use element of the comprehensive watershed plan; the upstream and downstream effect of such structural works on flood discharges and stages shall be determined; and any such structural

works which may significantly increase upstream or downstream peak flood discharges should be used only in conjunction with complementary facilities for the storage and movement of the incremental floodwaters through the watershed stream system. Channel modifications, dikes, or floodwalls shall not increase the height of the 100-year recurrence interval flood by more than one-half foot in any unprotected upstream or downstream stream reaches. Increases in flood stages in excess of one-half foot resulting from any channel, dike, or floodwall construction shall be contained within the upstream or downstream extent of the channel, dike, or floodwall, except where topographic or land use conditions could accommodate the increased stage without creating additional flood damage potential.

7. The height of dikes and floodwalls shall be based on the high water surface profiles for the 100-year recurrence interval flood prepared under the comprehensive watershed study, and shall be capable of passing the 100-year recurrence interval flood with a freeboard of at least two feet.

8. The construction of channel modifications, dikes, or floodwalls shall be deemed to change the limits and extent of the associated floodways and floodplains. However, no such change in the extent of the associated floodways and floodplains shall become effective for the purposes of land use regulation until such time as the channel modifications, dikes, or floodwalls are actually constructed and operative. Any development in a former floodway or floodplain located to the landward side of any dike or floodwall shall be provided with adequate drainage so as to avoid ponding and associated damages.

9. Reduced regulatory flood protection elevations and accompanying reduced floodway or floodplain areas resulting from any proposed dams or diversion channels shall not become effective for the purposes of land use regulation until the reservoirs or channels are actually constructed and operative.

10. All water control facilities other than bridges and culverts, such as dams and diversion channels, so located on the stream system that failure would damage only agricultural lands and isolated farm buildings, shall be designed to accommodate at least the hydraulic loadings resulting from a 100-year recurrence interval flood. Water control facilities so located on the stream system that failure could jeopardize public health and safety, cause loss of life, or seriously damage homes, industrial and commercial buildings, and important public utilities or result in closure of principal transportation routes shall be designed to accommodate a flood that approximates the standard project flood or the more severe probable maximum flood, depending on the ultimate probable consequences of failure.[a]

PRINCIPLE

Floodlands that are unoccupied by, and not committed to, urban development should be retained in an essentially natural open space condition supplemented with the development of selected areas for public recreational uses. Maintaining floodlands in open uses will serve to protect one riverine community from the adverse effects of the actions of others by discouraging floodland development which would significantly aggravate existing flood problems or create new flood problems upstream or downstream; will preserve natural floodwater conveyance and storage capacities; will avoid increased peak flood discharges and stages; will contribute to the preservation of wetland, woodland, and wildlife habitat as part of a continuous linear system of open space, and will immeasurably enhance the quality of life for both the urban and rural population by preserving and protecting the recreational, aesthetic, ecological, and cultural values of riverine areas.

STANDARDS

1. All public land acquisitions, easements, floodland use regulations, and other measures intended to eliminate the need for water control facilities shall, in all areas not already in intensive urban use or committed to such use, encompass at least all of the riverine areas lying within the 100-year recurrence interval flood inundation line.

2. Where hydraulic floodways are to be delineated, they shall to the maximum extent feasible accommodate existing, committed, and planned floodplain land uses.

3. In the determination of a hydraulic floodway, the hydraulic effect of the potential floodplain encroachment represented by the floodway shall be evaluated on the basis of an equal degree of encroachment for a significant reach on both sides of the stream, and the degree of encroachment shall be limited so as to not raise the peak stage of the 100-year recurrence interval flood by more than 0.5 foot. Larger stage increases may be acceptable for reaches having topographic or land use conditions which could accommodate such stage increases, whereas in some instances, allowable flood stage increases may be less than 0.5 foot where such increased stages may be expected to significantly aggravate flood problems and increase flood damages, and where adjoining communities are affected.

OBJECTIVE NO. 2

An integrated system of land management and water quality control facilities and pollution abatement devices adequate to assure a quality of surface water necessary to meet the water uses shown on Map 1.

Table 4 (continued)

PRINCIPLE

Surface water is one of the most valuable resources of southeastern Wisconsin; and, even under the effects of increasing population and economic activity levels, the potential of natural stream waters to serve a reasonable variety of beneficial uses, in addition to the single-purpose function of waste transport and assimilation, should be protected and preserved.

STANDARDS

1. All waters shall meet those water quality standards set forth in Table 96 of this report commensurate with the adopted water use objectives.

2. Water quality standards commensurate with adopted water use objectives are applicable at all times except during periods when streamflows are less than the average minimum seven-day low flow expected to occur on the average of once every 10 years.

OBJECTIVE NO. 3

The attainment of sound groundwater resource development and protective practices to minimize the possibility for pollution and depletion of the groundwater resources.

PRINCIPLE

Sound practices in the location, installation, and operation of water supply wells and waste treatment and disposal facilities can reasonably assure a continuing supply of good quality groundwater at reasonable cost.

STANDARDS

1. Groundwater withdrawals should be made so as to prevent undue interference with adjacent withdrawal points, and the capacities and withdrawal rates should be related to potential yield and total demand on the aquifers penetrated.

2. Wells should be constructed so as not to permit contamination of the aquifer through the well during construction or during subsequent operation.

3. Waste conveyance, treatment, and disposal facilities, located above or below ground surface, both public and private, should be designed, constructed, and operated in a manner to prevent migration or infiltration of contaminants into sources of usable groundwater. These facilities include pipes, tunnels, septic tanks, leaching areas, sanitary landfills, and injection wells.

[a] *These flood events, which have been formulated and used by the U. S. Army Corps of Engineers, are defined and discussed in Chapter VII, SEWRPC Planning Guide No. 5, Floodland and Shoreland Development Guide, November 1968.*

Source: SEWRPC.

Appendix D

SELECTED DATA ON BUILDINGS THAT ARE POTENTIALLY WITHIN THE 100-YEAR RECURRENCE INTERVAL FLOODPLAIN IN THE CITY OF BROOKFIELD

NOTES:

1. This appendix includes:
   a. Cross reference of Appendix D and Table 9 on page of text.
   b. Map showing 27 potential floodprone structures.
   c. Table of flood damages for each property.
   d. Table showing flood depths, property values, key elevations, and estimated damage for 10-, 50-, and 100-year floods.
2. Structure numbers noted with an (R) indicate repetitive-loss structures.
3. Structure number 10R has been purchased and razed under City-FEMA-Wisconsin Department of Military Affairs, Division of Emergency Management program. In addition, the City has purchased and razed a structure at 375 JoAnne Drive in the Fox River watershed under the same program.
4. Structures numbers 4, 5, 6, 7, 12R, and 17 are planned for removal with City application for funding under FEMA HMGP program. Cost-effectiveness analyses based upon damages and need for detention basin site area (see Dousman Ditch and Underwood Creek system plan).
5. Structure numbers 1, 2, 3, and 8 are planned for floodproofing or removal depending upon more-detailed field survey and structure evaluation (see Dousman Ditch and Underwood Creek system plan).
6. Structures 9R, 13R, 14R, 15, 16, and 26 are not in floodplain based upon updated analyses (see Dousman Ditch and Underwood Creek system plan).
7. Structures 19, 20, 21, 22, 23, 24, and 25 are not significantly impacted by the floodplain, as they are built on fill above the floodplain (Fox River subwatershed).
8. Structure 11R is outside the floodplain. Drainage and sanitary sewer problems are being evaluated (Fox River subwatershed).
9. Structures 18 and 27 are in shallow floodplain area. Solutions are being evaluated (Fox River subwatershed).

10. Structure foundation data.

    a. Data is available on all residential structures. All, except structure 19, have full basements. Structure 19 has a partial basement.

    b. The commercial and industrial buildings were assumed to have no basements.

    c. The above information was used in establishing potential flood damages.

11. The estimates of flood depths are based upon the flood flows and stages included in the FIS FEMA study.

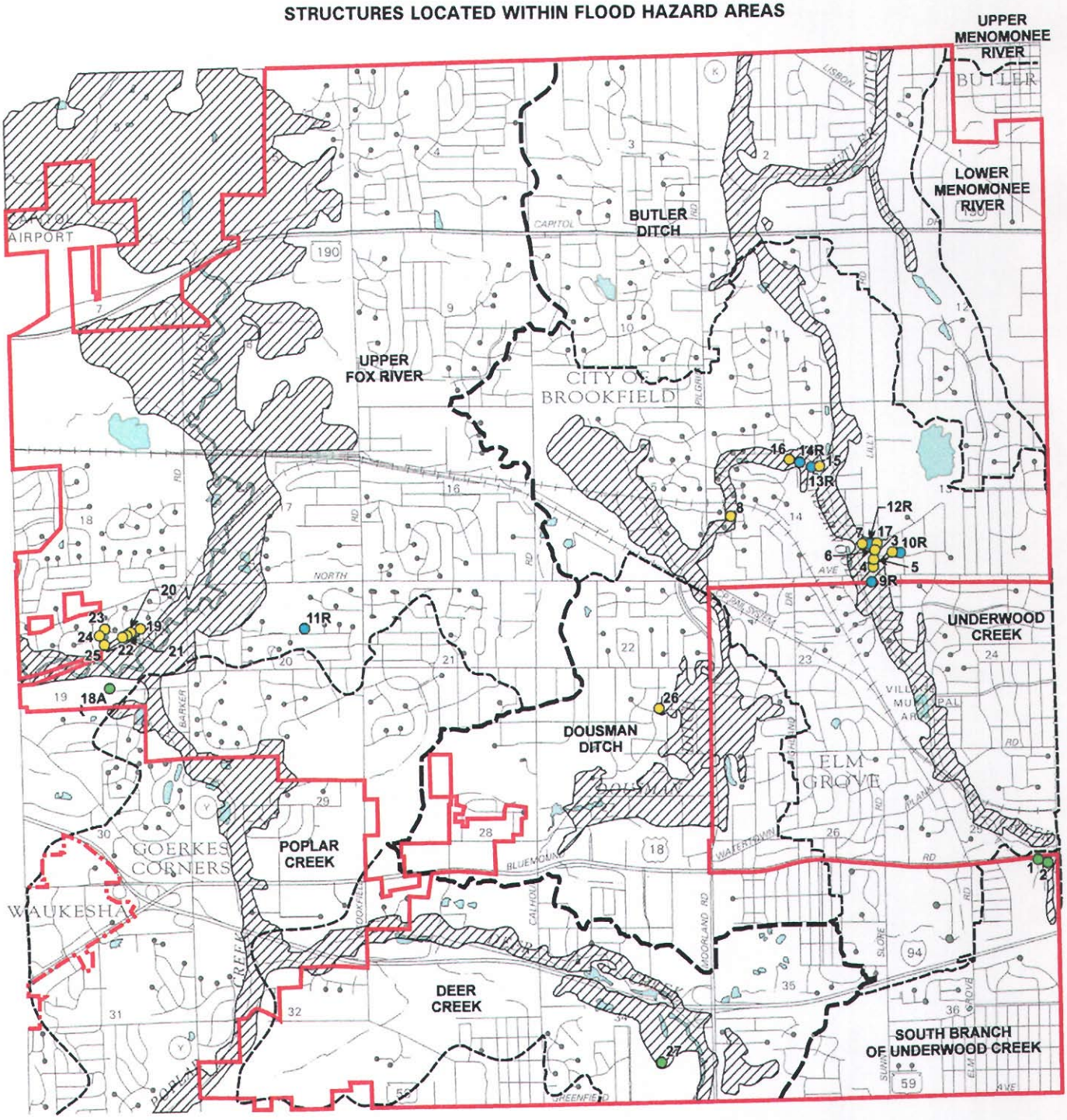
12. The buildings listed are shown to be in the 100-year recurrence interval floodplain based upon the best available topographic mapping, except as noted. Field surveys would be required to determine the precise relationship of each property to the floodplain. Such surveys could result in a reduction or increase in the total number of buildings located within the floodplain.

CROSS REFERENCE FOR APPENDIX D AND TABLE 19

Structure Numbers In Appendix D	Subwatershed Location	Recommended Mitigation Measures	Table 9 Element
10R	Underwood Creek	Acquire and remove	Completed prior to publication of Table 9 in report.
4, 5, 6, 7, 12R, 17	Underwood Creek	Acquire and remove	Second 10 (p. 74)
9R	Underwood Creek	No direct flood hazard. Problem solved by fill plus lower stage due to detention	No direct flood hazard. No cross reference.
13R, 14R	Underwood Creek	Beyond limits of floodplain. Sanitary sewer backup problem planning are ongoing	No direct flood hazard. No cross reference.
11R	Fox River	Beyond limits of flood-plain. Drainage and sanitary sewer backup problem system planning are ongoing for this area.	No cross reference. Subwatershed planning is underway.
1, 2, 3, 8	Underwood Creek	Floodproof or acquire and remove	11-13 (p. 74) 10-13 (p. 70)
1, 5, 16, 26	Underwood Creek	Beyond limits of floodplain based upon updated analyses; no known problems.	8 (p. 67) for structure 26
19, 20, 21, 22, 23, 24, 25	Fox River	Build on fill. Outside of flood-plain. No known problems.	No cross reference. Subwatershed planning is underway.
18, 27	Fox River and Deer Creek	Shallow flooding (less than 0.5 feet). Flood mitigation planning is ongoing for area.	No cross reference. Subwatershed planning is underway.

Map D-1

STRUCTURES LOCATED WITHIN FLOOD HAZARD AREAS



- SUBCONTINENTAL DIVIDE
- SUBWATERSHED BOUNDARY
- CITY OF BROOKFIELD CORPORATE LIMIT
- CITY OF WAUKESHA CORPORATE LIMIT
- FLOODPLAIN (100 YEAR RECURRENCE INTERVAL)
- RESIDENTIAL STRUCTURE
- BUSINESS OR COMMERCIAL STRUCTURE
- REPETITIVE LOSS STRUCTURE
- 7 STRUCTURE ID NUMBER (SEE APPENDIX D)

GRAPHIC SCALE
0 1/2 1 MILES
0 2000 4000 6000 FEET

Source: City of Brookfield, FEMA, and SEWRPC.

Table D-1

EXPECTED ANNUAL FLOOD DAMAGE PER PROPERTY FOR THE CITY OF BROOKFIELD

BUILDING I.D. #	TYPE OF BUILDING	STREAM	RIVER MILE	FLOOD DAMAGES ($) 100-YR	50-YR	10-YR	EXPECTED ANNUAL FLOOD DAMAGE ($)
1	Commercial	Underwood Creek	2.66	89010	76900	66750	37503
2	Commercial	Underwood Creek	2.77	Combined with Building 1			
3	S.F. Residential	Underwood Creek	4.92	13920	12100	0	753
4	S.F. Residential	Underwood Creek	4.88	5920	0	0	89
5	S.F. Residential	Underwood Creek	4.91	6330	0	0	95
6	S.F. Residential	Underwood Creek	4.97	16300	14870	0	914
7	S.F. Residential	Underwood Creek	3.78	12790	9350	0	613
8	S.F. Residential	Underwood Creek	6.41	23860	5970	1500	1362
9(R)/a	Commercial	Underwood Creek	4.80	0	0	0	0
10(R)	S.F. Residential	Underwood Creek	4.92	Owned by City of Brookfield			0
11(R)/b	S.F. Residential	Fox River	184.3	0	0	0	0
12(R)	S.F. Residential	Underwood Creek	4.98	10660	0	0	160
13(R)/c	S.F. Residential	Underwood Creek	5.51	0	0	0	0
14(R)	S.F. Residential	Underwood Creek	5.57	11550	0	0	173
15/d	S.F. Residential	Underwood Creek	5.46	0	0	0	0
16/e	S.F. Residential	Underwood Creek	5.64	0	0	0	0
17	S.F. Residential	Underwood Creek	4.97	10500	0	0	158
18A	Industrial	Fox River	183.35	417300	24610	0	7367
19/f	S.F. Residential	Fox River	183.66	0	0	0	0
20/f	S.F. Residential	Fox River	183.63	0	0	0	0
21/f	S.F. Residential	Fox River	183.62	0	0	0	0
22/f	S.F. Residential	Fox River	183.58	0	0	0	0
23/f	S.F. Residential	Fox River	183.23	0	0	0	0
24/f	S.F. Residential	Fox River	183.23	0	0	0	0
25/f	S.F. Residential	Fox River	183.23	0	0	0	0
26	S.F. Residential	Dousman Ditch	0.87	40540	22200	0	1607
27	Commercial	Deer Creek	2.93	157840	121410	0	7831
				816520	287410	68250	58624

a Property has been altered through filling and regrading and may no longer be subject to flooding.

b Property is not located near an identified floodplain area. Damages are due to localized drainage problems.

c Building is not located in a floodplain based upon topographic mapping. Damages are likely due to sanitary sewer backup.

d Island

e 1998 large-scale topographic map shows building to be out of floodplain.

f Post-FIRM building identified as being in the floodplain based upon administrative agreement between the City of Brookfield and FEMA. These buildings are constructed on fill and are not in contact with the floodplain, but they are identified by FEMA as being in the floodplain because their basement floors are below the 100-year flood stage.

Source: City of Brookfield and SEWRPC.

Table D-2

10-YEAR FLOOD DAMAGE COMPUTATIONS FOR THE CITY OF BROOKFIELD

BUILD. I.D. #	TYPE OF BUILDING	STREAM	RIVER MILE	GROUND EL. AT BUILDING (FT NGVD)/g	ASSUMED FIRST FL. ELEV. (FT NGVD)	10-YEAR FLOOD ELEV. (FT NGVD)	DEPTH OF INUNDATION REL. TO 1ST FLOOR (FT)	ASSESSED VALUE($)	BUILDING MARKET VALUE($)	BUILDING MARKET VALUE PLUS CONTENTS ($)/j	% DAMAGES	DAMAGES ($) DIRECT	DAMAGES ($) INDIRECT/k	TOTA
1	Commercial	Underwood Creek	2.66	722.4	722.9	724.8/h	1.9	155600	185902	278853	17.1	47680	19070	667
2	Commercial	Underwood Creek						Combined with Building 1						
8	Residential	Underwood Creek	6.41	801.5	809.5	803.0	-6.5/I	157300	187933	216123	0.6	1300	200	150
								312900	373835	494976		48980	19270	682

g Ground elevation of the property as shown on 1998 large-scale topographic map.

h Flood stage determined by Flood Insurance Study for the Village of Elm Grove by FEMA in 1982. Other flood stages are determined by Flood Insurance Study for the City of Brookfield by FEMA in 1986.

I Exposed finished basement.

j 1.5 times the building market value if the depth of inundation relative to first floor is +, 1.15 times if -.

k 40 percent of direct damage for commercial/industrial buildings, 15 percent for residential buildings.

Source: City of Brookfield and SEWRPC.

Table D-3

50-YEAR FLOOD DAMAGE COMPUTATIONS FOR THE CITY OF BROOKFIELD

BUILD. I.D. #	TYPE OF BUILDING	STREAM	RIVER MILE	GROUND EL. AT BUILDING (FT NGVD)/g	ASSUMED FIRST FL. ELEV. (FT NGVD)	50-YEAR FLOOD ELEV. (FT NGVD)	DEPTH OF INUNDATION REL. TO 1ST FLOOR (FT)	ASSESSED VALUE($)	BUILDING MARKET VALUE($)	BUILDING MARKET VALUE PLUS CONTENTS ($)/j	% DAMAGES	DAMAGES ($) DIRECT	DAMAGES ($) INDIRECT/k	DAMAGES ($) TOTAL
1	Commercial	Underwood Creek	2.66	722.4	722.9	725.3/h	2.4	155600	185902	278853	19.7	54930	21970	76900
2	Commercial	Underwood Creek						Combined with Building 1						
3	Residential	Underwood Creek	4.92	751.5	752.5	751.8	-0.7	82300	98327	113076	9.3	10520	1580	12100
6	Residential	Underwood Creek	4.97	750.7	751.7	751.9	0.2	57700	68937	103405	12.5	12930	1940	14870
7	Residential	Underwood Creek	3.78	746.0	747.4	746.5/h	-0.9	70400	84110	96726	8.4	8130	1220	9350
8	Residential	Underwood Creek	6.41	801.5	809.5	806.0	-3.5/I	157300	187933	216123	2.4	5190	780	5970
18A	Industrial	Fox River	183.35	822.5	824.0	823.6	-0.4	2225100	2658423	3057186	0.7	21400	3210	24610
26	Residential	Dousman Ditch	0.87	827.0	828.0	827.5	-0.5	140500	167861	193041	10.0	19300	2900	22200
27	Commercial	Deer Creek	2.93	836.5	837.0	837.0	0.0	691300	825926	1238889	7.0	86720	34690	121410
								3580200	4277419	5297300		219120	68290	287410

g Ground elevation of the property as shown on 1998 large-scale topographic map.

h Flood stage determined by Flood Insurance Study for the Village of Elm Grove by FEMA in 1982. Other flood stages are determined by Flood Insurance Study for the City of Brookfield by FEMA in 1986.

I Exposed finished basement.

j 1.5 times the building market value if the depth of inundation relative to first floor is +, 1.15 times if -.

k 40 percent of direct damage for commercial/industrial buildings, 15 percent for residential buildings.

Source: City of Brookfield and SEWRPC.

Table D-4

100-YEAR FLOOD DAMAGE COMPUTATIONS FOR THE CITY OF BROOKFIELD

BUILD. I.D. #	TYPE OF BUILDING	STREAM	RIVER MILE	GROUND EL. AT BUILDING (FT NGVD)/g	ASSUMED FIRST FL. ELEV. (FT NGVD)	100-YEAR FLOOD ELEV. (FT NGVD)	DEPTH OF INUNDATION REL. TO 1ST FLOOR (FT)	ASSESSED VALUE($)	BUILDING MARKET VALUE($)	BUILDING MARKET VALUE PLUS CONTENTS ($)/j	% DAMAGES	DAMAGES ($) DIRECT	DAMAGES ($) INDIRECT/k	DAMAGES ($) TOTAL
1	Commercial	Underwood Creek	2.66	722.4	722.9	725.9/h	3.0	155600	185902	278853	22.8	63580	25430	89010
2	Commercial	Underwood Creek						Combined with Building 1						
3	Residential	Underwood Creek	4.92	751.5	752.5	752.2	-0.3	82300	98327	113076	10.7	12100	1820	13920
4	Residential	Underwood Creek	4.88	752.1	753.6	752.1	-1.5	61500	73477	84498	6.1	5150	770	5920
5	Residential	Underwood Creek	4.91	752.2	753.7	752.2	-1.5	65600	78375	90131	6.1	5500	830	6330
6	Residential	Underwood Creek	4.97	750.7	751.7	752.3	0.6	57700	68937	103405	13.7	14170	2130	16300
7	Residential	Underwood Creek	3.78	746.0	747.4	747.3/h	-0.1	70400	84110	96726	11.5	11120	1670	12790
8	Residential	Underwood Creek	6.41	801.5	809.5	808.9	-0.6/I	157300	187933	216123	9.6	20750	3110	23860
9(R)/a	Commercial	Underwood Creek	4.80	754.0	754.5	751.8/h	N/A	2370900	2832616	4248925	N/A	0	0	0
10(R)	Residential	Underwood Creek	4.92	751.5	752.5	752.2	N/A	Owned by City of Brookfield			N/A	0	0	0
11(R)/b	Residential	Fox River	184.30	912.0	913.0	824.5	N/A	193100	230705	346057	N/A	0	0	0
12(R)	Residential	Underwood Creek	4.98	752.2	753.2	752.3	-0.9	80300	95938	110329	8.4	9270	1390	10660
13(R)/c	Residential	Underwood Creek	5.81	758.5	759.5	756.3	N/A	151000	180406	270609	N/A	0	0	0
14(R)	Residential	Underwood Creek	5.57	757.5	759.5	757.7	-1.8	149100	178136	204857	4.9	10040	1510	11550
15/d	Residential	Underwood Creek	5.46	756.0	757.0	754.0	N/A	554800	662843	994265	N/A	0	0	0
16/e	Residential	Underwood Creek	5.64	760.2	761.2	759.1	N/A	128500	153524	230287	N/A	0	0	0
17	Residential	Underwood Creek	4.97	752.2	753.2	752.3	-0.9	79100	94504	108680	8.4	9130	1370	10500
18A	Industrial	Fox River	183.35	822.5	824.0	824.4	0.4	2225100	2658423	3987634	9.1	362870	54430	417300
19/f	Residential	Fox River	183.66	830.0	831.0	824.4	N/A	203600	243250	364875	N/A	0	0	0
20/f	Residential	Fox River	183.63	829.0	830.0	824.4	N/A	256900	306930	460394	N/A	0	0	0
21/f	Residential	Fox River	183.62	829.5	830.5	824.4	N/A	194800	232736	349104	N/A	0	0	0
22/f	Residential	Fox River	183.58	829.0	830.0	824.4	N/A	211700	252927	379391	N/A	0	0	0
23/f	Residential	Fox River	183.23	829.3	830.3	824.4	N/A	207200	247551	371326	N/A	0	0	0
24/f	Residential	Fox River	183.23	829.3	830.3	824.4	N/A	189000	225806	338710	N/A	0	0	0
25/f	Residential	Fox River	183.23	828.0	829.0	824.4	N/A	253800	303226	454839	N/A	0	0	0
26	Residential	Dousman Ditch	0.87	827.0	828.0	828.7	0.7	140500	167861	251792	14.0	35250	5290	40540
27	Commercial	Deer Creek	2.93	836.5	837.0	837.4	0.4	691300	825926	1238889	9.1	112740	45100	157840
								8931100	10670370	15693775		671670	144850	816520

a Property has been altered through filling and regrading and may no longer be subject to flooding.

b Property is not located near an identified floodplain area. Damages are due to localized drainage problems.

c Building is not located in a floodplain based upon topographic mapping. Damages are likely due to sanitary sewer backup.

d Island

e 1998 large-scale topographic map shows building to be out of floodplain.

f Post-FIRM building identified as being in the floodplain based on administrative agreement between the City of Brookfiled and FEMA. These buildings are constructed on fill and are not in contact with the floodplain, but they are identified by FEMA as being in the floodplain because their basement floors are below the 100-year flood stage.

g Ground elevation of the property as shown on 1998 large-scale topographic map.

h Flood stage determined by Flood Insurance Study for the Village of Elm Grove by FEMA in 1982. Other flood stages are determined by Flood Insurance Study for the City of Brookfield by FEMA in 1986.

I Exposed finished basement.

j 1.5 times the building market value if the depth of inundation relative to first floor is +, 1.15 times if -.

k 40 percent of direct damage for commercial/industrial buildings, 15 percent for residential buildings.

Source: City of Brookfield and SEWRPC.

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Appendix E

GENERAL LOCATIONS OF IDENTIFIED FLOODING AND STORMWATER DRAINAGE PROBLEM AREAS IN THE CITY OF BROOKFIELD

Table E-1

GENERAL LOCATIONS AND SELECTED CHARACTERISTICS OF FLOODING AND STORMWATER DRAINAGE PROBLEM AREAS IN THE CITY OF BROOKFIELD IDENTIFIED BY CITY STAFF: 1995

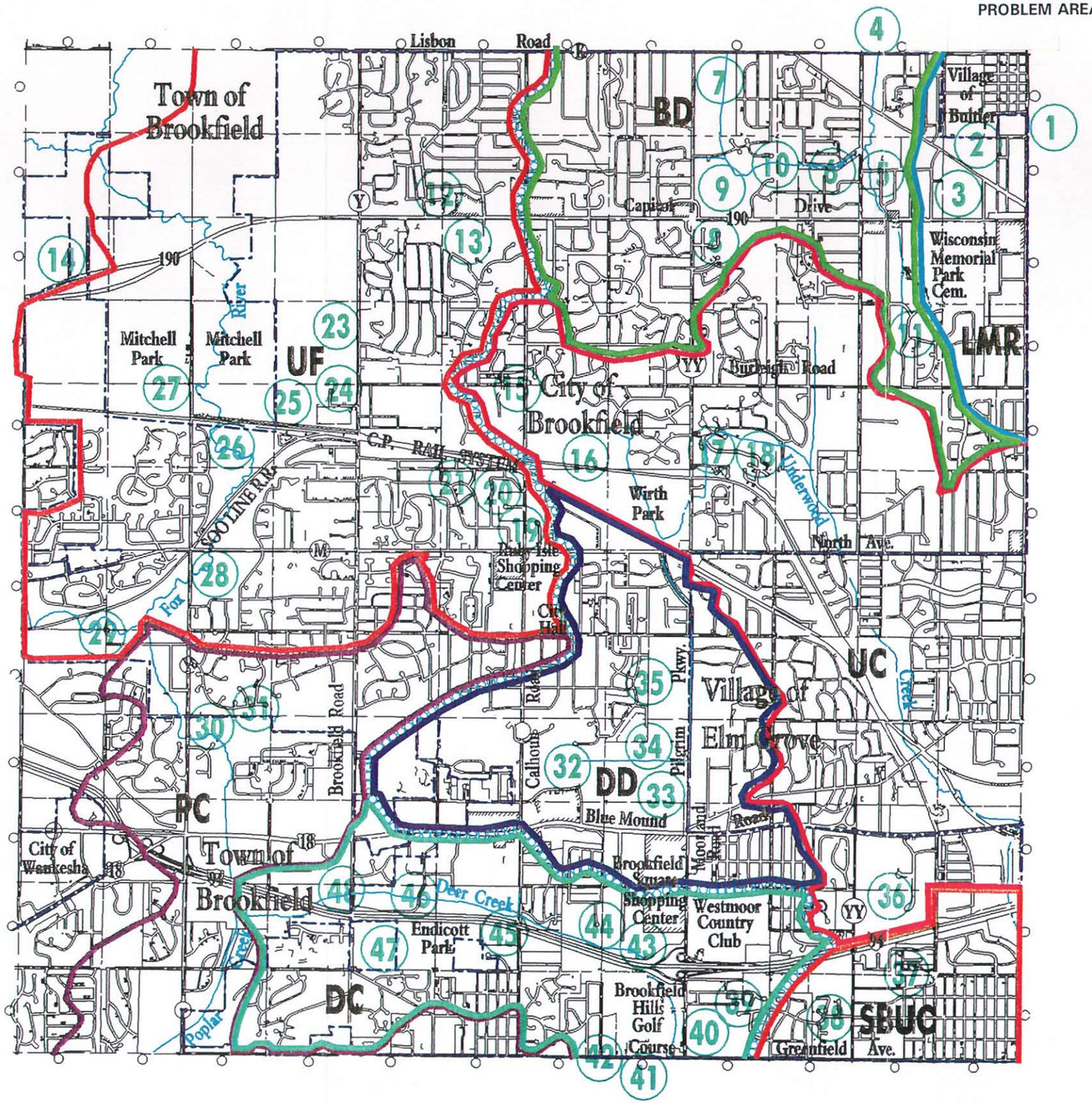
Problem Area[a]	Section	Quarter Section	General Description	Responsible Agency				
				City		Town of Brookfield	Wisconsin DOT	Railroad
				O&M	Contract			
1	6	NW	Storm sewer under capacity		•			
2	1	NE	Street flooding		•			
3	1	SE	Ditch cleaning	•				
4	1	NW	Ditch cleaning and improvement		•			
5	1	SW	Street flooding		•			
6	2	SE	Street flooding		•			
7	2	NW	Increased urban runoff		•			
8	11	NW	Channel stabilization	•				
9	2	SW	Resize pond for quantity/quality		•			
10	2	SE	Retrofit pond for water quality		•			
11	12	NE	Replace storm sewer		•			
12	4	SE	Pond cleaning		•			
13	9	NE	Ditch maintenance	•				
14	7	NW	Ditch/structure maintenance			•		
15	15	NW	Street flooding		•			
16	15	NW	Ditch maintenance	•				
17	14	NW	Pond cleaning/dam reconstruction		•			
18	14	NW	Clearing and grubbing	•				
19	15	SW	Pond cleaning/ditch stabilization	•				
20	16	SE	Ditch stabilization	•				
21	16	NE	Rehabilitate structure under railroad					•
22	22	NW	Ditch stabilization					•
23	23	SE	Ditch maintenance	•				
24	17	NE	Ditch maintenance	•				
25	17	NW	Street flooding		•			
26	17	NW	Remove railroad bridge pilings	•				
27	18	NE	Drainage improvements		•			
28	20	NW	Clearing and grubbing of river/bridges	•				
29	19	NW	Clearing and grubbing of river/bridges	•				
30	29	NW	Clearing and grubbing of river/bridges			•		
31	20	SW	Install catch basin at outlet	•				
32	27	NW	Expand area served by pond		•			
33	27	SE	Urban stormwater treatment		•			
34	27	NE	Construct quantity/quality facility		•			
35	22	SE	Ditch maintenance	•				
36	36	NW	Channel stabilization	•				
37	36	SW	Channel stabilization	•				
38	35	SE	Storm sewer construction				•	
39	35	SW	Install catch basin at outfall	•				
40	35	SW	Retrofit pond for stormwater quality		•			
41	34	SE	Conveyance capacity and maintenance				•	
42	34	SE	Conveyance capacity and maintenance				•	
43	34	NE	Conveyance capacity and maintenance				•	
44	34	NE	Private pond maintenance	•				
45	33	NE	Ditch maintenance	•				
46	33	NE	Clearing and grubbing	•				
47	33	NW	Construct facilities for urban runoff		•			
48	32	NE	Construct facilities for urban runoff		•			

[a] *See Map E-1.*

Source: City of Brookfield and Rust Environmental & Infrastructure.

Map E-1

GENERAL LOCATIONS OF FLOODING AND STORMWATER DRAINAGE
PROBLEM AREAS IN THE CITY OF BROOKFIELD IDENTIFIED BY CITY STAFF: 1995



N

0 4000' 8000'

Legend

- Subcontinental Divide
- Municipal Boundaries
- (XX) Problem Area Number

Fox River Watershed

- PC - Poplar Creek
- DC - Deer Creek
- UF - Upper Fox

Menomonee River Watershed

- DD - Dousman Ditch
- SBUC - South Branch of Underwood Creek
- UC - Underwood Creek
- BD - Butler Ditch
- LMR - Lower Menomonee River

FLOODING & STORMWATER PROBLEM AREAS
CITY OF BROOKFIELD
STORMWATER MANAGEMENT GUIDE

RUST ENVIRONMENT & INFRASTRUCTURE

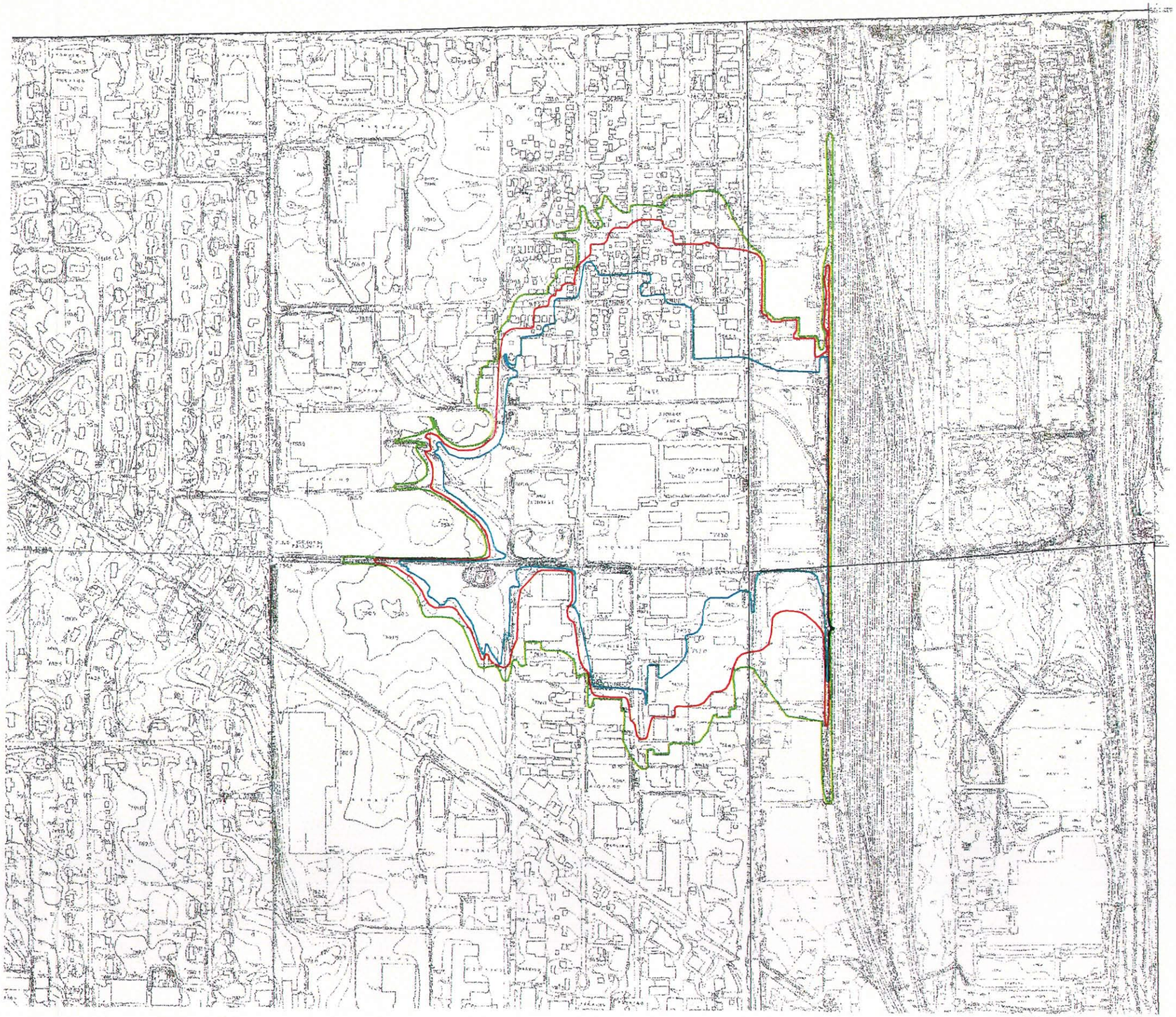
Source: City of Brookfield and Rust Environmental & Infrastructure.

Appendix F

EXCERPT FROM 124TH AND CONGRESS STREETS STORMWATER ANALYSIS PREPARED BY RUEKERT & MIELKE, INC., FEBRUARY 1998

Map F-1

EXISTING FLOODPLAIN ELEVATIONS IN
THE 124TH AND CONGRESS STREETS AREA



0 1 2 300 600
SCALE IN FEET

LEGEND

EXISTING 2 YEAR CONDITIONS
EXISTING 10 YEAR CONDITIONS
EXISTING 100 YEAR CONDITIONS

Date: January 20, 1998

Ruekert | Mielke
Professional Engineers
Registered Land Surveyors
W239 N1812 Rockwood Drive
Waukesha, Wisconsin 53188 (414) 542-5733

I:\0292024\Exflood.dwg

Subbasin A: 53.63 Ac
2yr=44.94 CFS
10yr=73.97 CFS
25yr=88.57 CFS
50yr=100.73 CFS
100yr=112.83 CFS
6/21/97=137.08 CFS

Subbasin B: 12.27 Ac
2yr=10.57 CFS
10yr=17.39 CFS
25yr=20.81 CFS
50yr=23.67 CFS
100yr=26.52 CFS
6/21/97=32.19 CFS

Subbasin C: 24.05 Ac
2yr=24.09 CFS
10yr=39.50 CFS
25yr=47.25 CFS
50yr=53.69 CFS
100yr=60.12 CFS
6/21/97=72.94 CFS

Subbasin D: 8.16 Ac
2yr=6.64 CFS
10yr=10.86 CFS
25yr=12.99 CFS
50yr=14.75 CFS
100yr=16.52 CFS
6/21/97=20.08 CFS

Subbasin E: 5.25 Ac
2yr=5.24 CFS
10yr=8.89 CFS
25yr=10.57 CFS
50yr=11.98 CFS
100yr=13.38 CFS
6/21/97=15.89 CFS

Subbasin F: 15.19 Ac
2yr=10.81 CFS
10yr=17.73 CFS
25yr=21.21 CFS
50yr=24.11 CFS
100yr=27.00 CFS
6/21/97=32.76 CFS

Subbasin G: 29.31 Ac
2yr=21.13 CFS
10yr=34.59 CFS
25yr=41.35 CFS
50yr=46.99 CFS
100yr=52.61 CFS
6/21/97=63.81 CFS

Subbasin H: 68.25 Ac
2yr=37.47 CFS
10yr=63.42 CFS
25yr=75.47 CFS
50yr=85.81 CFS
100yr=95.52 CFS
6/21/97=113.52 CFS

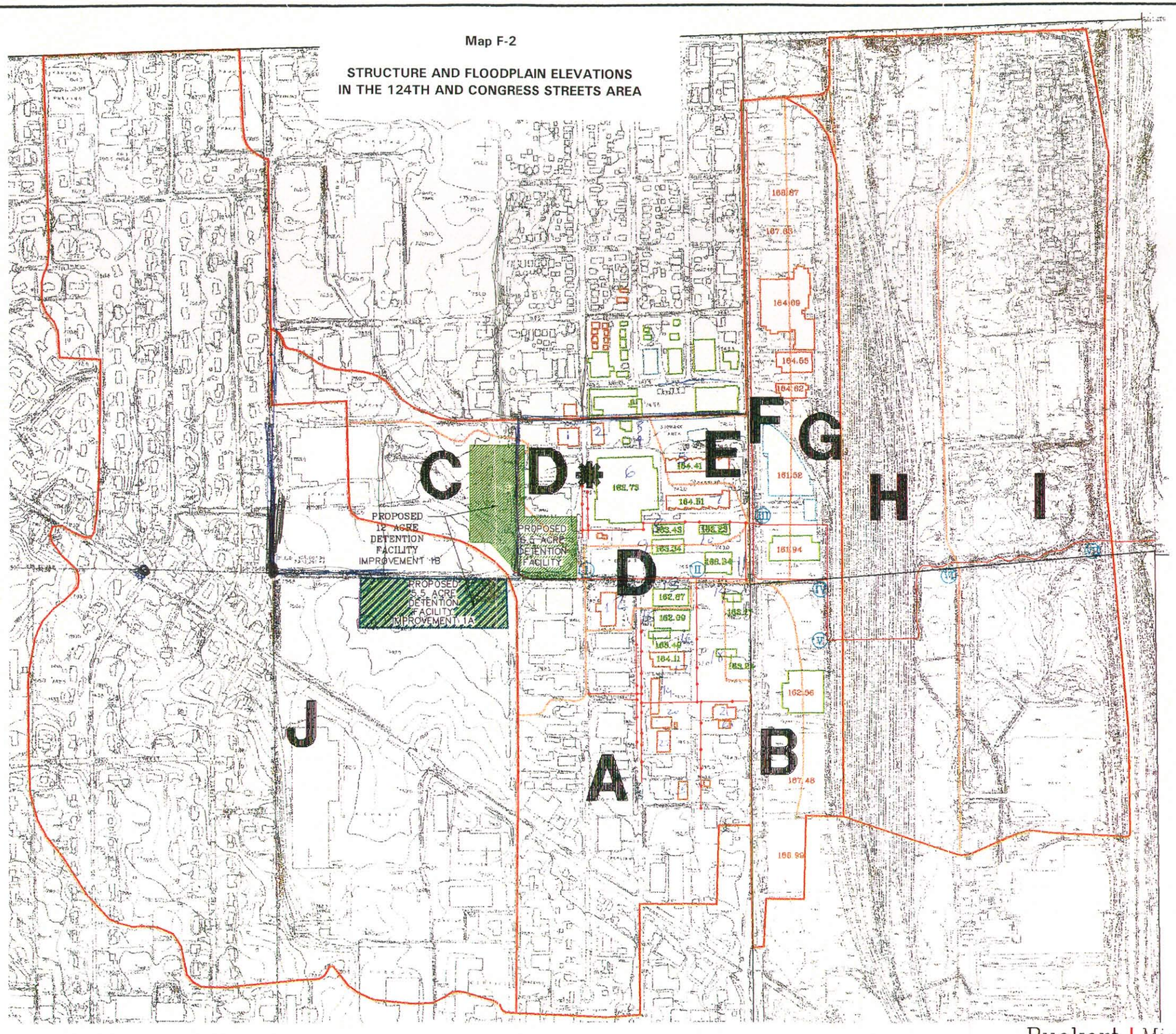
Subbasin I:
2yr=62.60 CFS
10yr=105.99 CFS
25yr=126.124 CFS
50yr=142.88 CFS
100yr=159.61 CFS
6/21/97=189.64 CFS

Subbasin D*: 25.55 Ac
2yr=27.40 CFS
10yr=46.32 CFS
25yr=55.09 CFS
50yr=62.38 CFS
100yr=69.66 CFS
6/21/97=82.71 CFS

Date: January 20, 1998

Map F-2

STRUCTURE AND FLOODPLAIN ELEVATIONS IN THE 124TH AND CONGRESS STREETS AREA



Subbasin J: 240 Ac
Proposed 5.5 Acre
Detention Facility
2yr Inflow=126.49 CFS
2yr Discharge=28.27 CFS
10yr Inflow=232.10 CFS
10yr Discharge=48.74 CFS
25yr Inflow=287.14 CFS
25yr Discharge=96.86 CFS
50yr Inflow=333.58 CFS
50yr Discharge=146.46 CFS
100yr Inflow=380.36 CFS
100yr Discharge=202.14 CFS

Subbasin J and Part of Subbasin C: 255 Ac
Proposed 12 Acre (5.5+6.5 Acre)
Detention Facility
2yr Inflow=137.91 CFS
2yr Discharge=11.82 CFS
10yr Inflow=262.98 CFS
10yr Discharge=33.21 CFS
25yr Inflow=323.15 CFS
25yr Discharge=44.34 CFS
50yr Inflow=373.88 CFS
50yr Discharge=46.94 CFS
100yr Inflow=424.94 CFS
100yr Discharge=48.74 CFS

N

0 1 2 300 600
SCALE IN FEET

LEGEND

- PRIMARY BASIN BOUNDARY
- SUBBASIN BOUNDARY
- 128.45 EXISTING FIRST FLOOR ELEVATION – PER CITY OF BROOKFIELD
- 123.45 EXISTING FIRST FLOOR ELEVATION – PER CITY OF WAUWATOSA
- 159.5–161.5
- 161.5–163.5
- 163.5–165.5
- (IV) STATION LOCATION WHERE FLOOD ELEVATIONS WERE CALCULATED IN REPORT
- EXISTING STORM SEWER & DITCHING

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